Technical Report 1207

Training Requirements for Visualizing Time and Space at Company and Platoon Level

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Aptima, Inc.

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14. ABSTRACT *(Maximum 200 words)* Success in military operations increasingly rests on the ability of small units to counter asymmetric threats in the varied and foreign urban settings that typify the contemporary operating environment (COE). However, the physical dimensions and cultural characteristics of urban environments dramatically compress and complicate the dynamics of space and time so fundamental to visualizing and executing company and platoon operations. To help leaders visualize the interactions of space and time (VISTA), a cognitive task analysis (CTA) was conducted based on workshops with active and retired military personnel (n = 50). The CTA used a representative scenario and supporting vignettes to elicit and identify the cognitive skills required to visualize time and space patterns in the COE such as vehicle and human traffic, tribal and political boundaries, and culturally sacred structures. The CTA underscored the need for visualization training in small units and identified a related set of training principles, stages, and techniques. On that basis, prototype examples of visualization training were developed in five modules that feature scenario-based contexts, multimedia delivery, and deliberate practice. A limited evaluation of the training resulted in positive and constructive guidance for future development and utilization.

15. SUBJECT TERMS training, cognitive task analysis, visualization, principles, platoon leaders, company leaders, time, space

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TRAINING REQUIREMENTS FOR VISUALIZING TIME AND SPACE AT COMPANY AND PLATOON LEVEL

EXECUTIVE SUMMARY

Research Requirement:

Increasingly, Army combat operations occur in densely-populated urban settings where the physical dimensions and cultural and social characteristics of the environment interact to dramatically compress and complicate the dynamics of the operating environment. The compression and complexity of the contemporary operating environment (COE) make it very difficult for company- and platoon-level leaders to develop the time and space visualization skills that are essential to effective small unit operations. To help leaders visualize the interactions of space and time (VISTA) in the COE, research is needed to identify and analyze critical visualization tasks and skills. This analysis can then provide a foundation for the design and development of training for these skills.

Procedure:

A scenario-based Cognitive Task Analysis (CTA) was conducted to gain insight into the time and space visualization challenges faced by small unit leaders and to identify the techniques and methods currently used to meet those challenges. Fifty active duty and retired Army personnel participated in a series of four CTA workshops focused around a scenario that captured key elements of the COE, with five vignettes that provided detail about situations within that overarching scenario. Workshop participants systematically developed and presented a Course of Action (COA) for each vignette and the research team questioned them about the aspects of time and space that they had considered in developing the COA, the cues they had observed, and the techniques they had employed in visualizing the operating environment. The participants, 36 of whom had recent deployment experience in Iraq or Afghanistan, were also asked to share any personal experiences in which they had been presented with similar challenges.

Findings:

The CTA results confirm earlier findings that breadth and depth of knowledge characterize the visualization skills of more expert leaders.

The analysis identified four principles regarding the dynamics of time and space in the COE:

- Time is compressed in the COE.
- Space is compressed in the COE.
- Human terrain further compresses time and space.
- Knowing the Area of Operations (AO) is the key to overcoming these challenges and exploiting time and space.

The primary barrier to effective visualization in the COE is lack of knowledge about the numerous, complex, interacting factors that characterize the AO. The fundamental handicaps to effective visualization are: (1) lack of knowledge about the aspects of the AO that should be included in the visualization (e.g., consider whether pedestrian crowds may slow travel progress on a planned route); (2) lack of detailed information about relevant aspects of the AO (e.g., large crowds gather on Wednesday afternoons at the marketplace); and (3) lack of knowledge about techniques to acquire the information that is needed (e.g., how does one find out that market place are important and key times they occur?).

Experienced leaders develop formal and informal techniques for gaining information about their AO, maintaining and updating that knowledge, and sharing that information with others. Specific techniques for gaining knowledge of the AO described in the Workshops include: attending briefs and after action reviews (AARs), sitting in on Right Seat Rides, and having informal conversations with the outgoing units. Specific techniques for maintaining knowledge of the AO include: engaging the population, using routine patrols as opportunities for mission rehearsals, and taking pictures of key people and places. Finally, specific techniques for sharing knowledge of the AO with incoming units include: conducting operations with the incoming unit, sharing storyboards from past missions, and giving tours of the AO.

Based on the CTA results, the research team developed a training prototype to assist small unit leaders in visualizing the effects of time and space within the COE. As a result of CTA findings, the training focused on strategies for acquiring, maintaining, and sharing knowledge of the AO. The training—based on the principles of deliberate practice, scenario-based learning, and multimedia learning—consists of five modules that use the vignettes reviewed during the CTA workshops. A limited evaluation resulted in positive feedback about the utility of the training, with suggested directions for future development. The evaluators were especially positive about the innovative visualization exercises included in the training, such as arranging a virtual sand table and viewing attack histories on an interactive map.

Utilization and Dissemination of Findings:

The current research contributes to identifying and understanding the skills required for visualizing time and space in the COE and the training requirements for these skills. Future training development efforts will benefit from the CTA findings particularly the identification of AO knowledge requirements and an extensive set of techniques for gaining, maintaining and sharing that knowledge. Training development efforts will benefit from the feedback obtained during evaluation of the prototype training modules. Notably, approaches to training and shaping visualization skills should include complementary low-technology (not computer-based) training formats for the austere environments often occupied by deployed personnel. Above all the findings model a training approach with feedback in the form of expert visualizations and considerations for mastering time and space challenges in the COE.

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Introduction

The Contemporary Operating Environment (COE) faced by today's Soldiers offers very different challenges than those faced during the Cold War. The enemy is no longer a large, slow-moving, monolithic entity such as the Soviet Union. Our enemies are diverse, numerous and include asymmetric threats—small bands of unknown and highly adaptive terrorists, insurgents, drug-traffickers, and other criminal elements (Strategy World, 2007). Attacks occur in densely populated urban settings where enemies can blend in among civilians, using them as human shields. The enemy goal is not to achieve a decisive military victory through superior numbers, but to inflict a small yet consistent number of casualties on U.S. forces, thereby eroding domestic political support.

Although the ability to visualize in time and space has always been a key skill for military leaders, the COE presents new levels of complexity and challenge for acquiring and employing visualization skills. In order to effectively operate in the COE, leaders must develop a realistic vision of the operating environment—not only the location and capabilities of friendly and enemy forces but the actions and reactions of non-combatants and the complex three-dimensional physical and cultural features of the urban environment.

The primary objective of this research was to identify and analyze the tasks and skills required to visualize the interaction of space and time in the COE. The research focused on battlefield visualization for small unit leaders. A secondary objective was to develop prototype training in visualization skills based on the analysis of skill requirements.

This report describes the methods and the results of the visualization of space and time (VISTA) research. The remainder of the introduction discusses findings from the literature on visualization skills for military leaders and the challenges that the COE presents for those skills. The next section describes a scenario-based Cognitive Task Analysis (CTA) data collection conducted with 50 active duty and retired military personnel. The CTA data collection was based on five vignettes focused on common missions for small units within an overall scenario that provided context.

An analysis conducted on the data follows, including principles for visualization, task-specific visualization skills needed by leaders, stages in knowledge acquisition for the Area of Operations (AO), and techniques for acquiring AO knowledge at each stage. The results of the CTA form a foundation for developing visualization training for small unit leaders. The next section describes the five prototype VISTA training modules developed based on the CTA results (details of the training are provided in the accompanying Research Note (Sidman & Garrity, 2007). An evaluation of two of the training modules is described in the following section. The final section summarizes the research.

Literature review

Prior to the CTA data collection, the research team reviewed existing literature and documentation on battlefield visualization skills to provide a basis for the development of vignettes and questions for the data collection. The team began with a review of critical Army Field Manuals (FMs) on Topographic Operations and Operations (U.S. Department of the Army, 2001a; U.S. Department of the Army, 2001b) to highlight doctrinal guidance for battlefield visualization. Next, the team searched the Defense Technical Information Center (DTIC) database to identify published studies that address these skills. Searching under keywords such as "company," "platoon," and "visualization" resulted in articles describing the cognitive requirements for small unit operations such as clearing a building (Phillips, McDermott, Thordsen, McCloskey, & Klein, 1998). These sources of information were supplemented by military literature such as Kilcullen's (2006) "Twenty-Eight Articles" and Lawrence's (1917) "Twenty-Seven Articles." Overall, these documents described the visualization challenges of a multidimensional COE that compresses and complicates the dynamics of time and space at the small unit level.

The visualization skills of military commanders and leaders

Previous research shows that the battlefield visualization skills of more-expert and less-expert commanders differ in measurable ways (Serfaty, MacMillan, Entin, & Entin, 1997). For example, in comparison to less expert commanders, experts spend more time studying the problem space; focus on deep, meaningful inter-relationships among the problem elements, rather than just their surface features; compare the current situation to previous situations that they have experienced; consider multiple COAs concurrently, rather than consecutively; conduct "mental experiments" to see if the various COAs will work; select the most promising COA; continually monitor the situation to see if it conforms with their expectations; and modify the COA, as necessary, based on the initial results (Means, Salas, Crandall, & Jacobs, 1995; Serfaty et al., 1997). Serfaty et al., (1997) found that, given identical descriptive materials about a situation, expert commanders rated the situation as more complex than less-expert commanders. The experts perceived complexity not visible to the novices. This research suggests that part of what is learned in battlefield visualization is the awareness of the deeper complexities and relationships in a situation that may not be obvious from surface features.

The effects of the multidimensional COE on time and space considerations

The nature of warfare in the COE is both irregular and asymmetric, characteristics that extend to time and space visualization as well. As such, it requires a response that covers the full spectrum of operations from offensive operations to defensive operations to stability and civil support operations. Furthermore, the responsibility for carrying out the wide variety of operations is pushed to lower echelons and junior officers. There are, therefore, key features of the COE that challenge small unit leaders as they make time and space estimates.

One of the key defining features of the COE is the urban setting. Threats may emerge from a variety of dimensions; on the surface, on top or within structures, underground, or from the air (see Figure 1). The COE is multidimensional (U.S. Department of Army, 2003a).

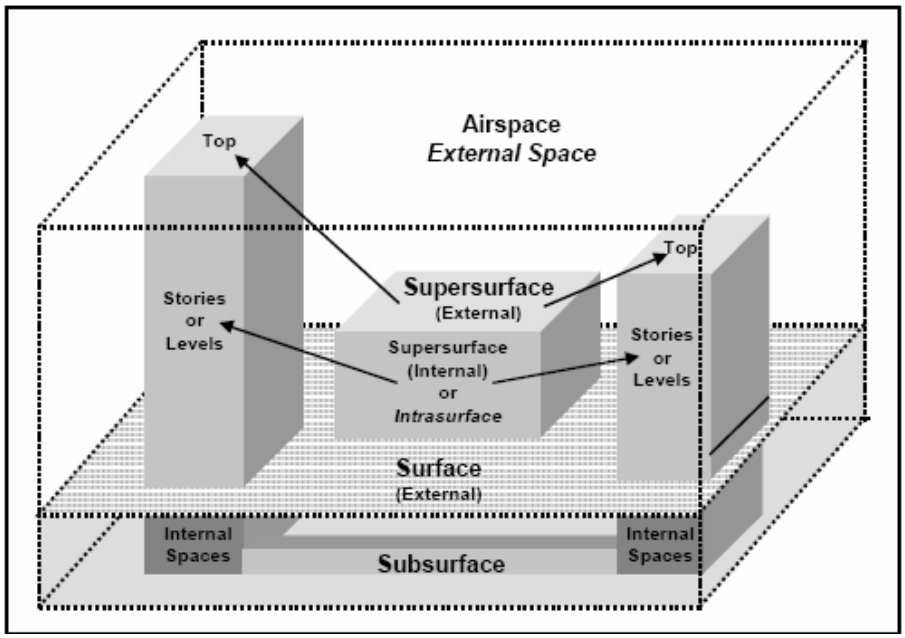

Figure 1. Depiction of the multidimensional COE from FM 3-06.

The multidimensional COE compresses both time and space. As David Kilcullen, a former company commander in the Australian Army and an expert in counterinsurgency operations has described, the enemy can emerge suddenly, and a battle can be decided on a street corner in seconds (Kilcullen, 2006). However, experts in contemporary operations have identified techniques by which one can control temporal and spatial factors so that they do not seem compressed. Kilcullen's "Twenty-Eight Articles" (2006) is the seminal paper documenting counterinsurgency techniques. Developed in the spirit of T.E. Lawrence's "Twenty-Seven Articles" (1917), and Kilcullen's articles are geared for coalition company commanders readying for deployment, organized chronologically around their preparation for deployment, deployment, and steady-state operations. There are a number of points the authors have in common that bridge history, including differences in their respective conflicts and their overall military experience. The most significant commonality is the principle of understanding the operating environment and every aspect of it—allies, enemy, culture, terrain, religion, interpersonal relationships, outside players and societal tempo—that is, the way people and places are. Lawrence advised leaders to "Learn all you can about your Ashraf and Bedu. Get to know their families, clans and tribes, friends and enemies, wells, hills and roads" (p. 126). Kilcullen's very first principle echoes that getting to know your AO is of the utmost importance:

> Know the people, the topography, economy, history, religion and culture. Know every village, road, field, population group, tribal leader and ancient grievance. Your task is to become the world expert on your district. If you don't know precisely where you will be operating, then study the general area. Read the map like a book: study it every night before sleep, and re-draw it from memory every morning, until you understand its patterns intuitively. Develop a mental model of your area—a framework in which to fit every new piece of knowledge you acquire. (pp. 103)

The benefits of developing knowledge of your AO have been described by current operational personnel. One benefit of knowing your AO is that "Once you know an area, you know when anything is strange or out of place. Your spider sense should tingle" (Colimore, 2006). Stewart, McCarthy, and Mullin (2004) describe this as the ability to know when "something has changed or does not seem right" (p.10). By observing what normal activities are in an area and being observant to changes in activities, one can predict insurgent actions (Cohen, Crane, Horvath, & Nagel, 2006; Kilcullen, 2006), perhaps even avoiding improvised explosive devices (IEDs) or snipers (Bradshaw, 2006).

For example, Phillips et al., (1998) identify several indicators of building fortification, such as the presence of freshly upturned dirt signifying a potential booby trap. Critically, some of these cues require that the Soldier understand what the area looked like beforehand in order to appreciate the significance of a change in the environment. If no change is perceived, then potential cues will be missed. If the change is perceived, then the Soldier can use that indicator to adjust his time or space estimates by becoming proactive (e.g., recalculating arrival time on the objective based on the need to disarm the booby trap, or determining a different route) instead of reactive (e.g., activating the booby trap and then determining what to do next).

Developing knowledge of your AO

If developing knowledge of your AO is the goal of visualization in the COE, then the critical question is how one can develop knowledge of the AO in order to facilitate more accurate time and space visualization. A logical starting point is conducting a terrain analysis to get to know your AO physically and there are both traditional and emerging methods of conducting terrain analysis and tools that facilitate each method. However, terrain analysis in the COE is not limited to the physical terrain. As Lawrence and Kilcullen suggest, understanding the cultural and civilian terrain is just as important.

Developing knowledge of the physical terrain. Traditional terrain analysis focuses on observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA), and the effects of those factors on friendly and enemy forces (U.S. Department of the Army, 2003b). While OCOKA provides a general framework for shaping terrain analysis, Rosenberger (1996) offers specific questions within the OCOKA framework that a commander or leader should ask himself to thoroughly analyze the physical terrain, and its effects on time and space. Questions with critical time and space emphases include (p. 34):

- Within your AO, what effect will terrain have on your and the enemy's ability to move forces, sustain mass and cohesion, and mass the effects of direct and indirect fires?
- Where will terrain constrict your movement, break up your formations and create a piecemeal presentation of your force?
- What movement rate (kilometers per hour) can you realistically sustain, given terrain conditions, visibility and weather?
- Where can you use terrain to isolate or separate enemy forces in time and space so they will never be able to bring overwhelming combat power to bear against your forces?

- How can you use terrain to control the battle tempo, delay the enemy's movement or buy time to reposition forces or reinforce? What terrain affords you superior agility to move and mass fires faster than your enemy?

There are a variety of tools available to the commander or leader to help answer these questions and develop a visualization of the COE. Tools can be anything from maps and satellite images to sensor based systems to visual operations orders (OPORD) to visual observation. While all of these are useful to the small-unit leader, they are often best used for different purposes.

While maps can be used to develop a preliminary understanding of the physical environment, they often do not capture critical details for lower echelons, such as irrigation canals created by farmers that could affect travel speed (Stewart et al., 2004). In response to the unreliability of maps, current imagery from mapping systems such as FalconView and ArcView, as well as unmanned aerial systems (UAS) images are included in the planning process. These images can be then modified by Soldiers using FalconView's overlay design capabilities to include numbered buildings, which provided a common framework for ground and air units (Stewart et al., 2004).

Another valuable tool to fill information gaps from maps or satellite imagery is photos taken by the Soldiers on the ground. These can be used to identify high value targets (HVTs) or to document the conditions of local roads or buildings. Kilcullen (2006) strongly encourages units to build up a library of photos not only for their own benefit, but to use in preparing the incoming units.

Beyond these common visualization tools, some units on the ground have adopted a novel approach to writing OPORDS: creating visual OPORDs. Such OPORDs have no standard format at the present time; however they may appear in one-slide PowerPoint format and include pictures and images as mentioned above. Hoffman and Shattuck (2006) identified several advantages of presenting OPORD content visually, such as the ability to depict relationships between entities and events, and to condense the OPORD from hundreds of pages.

During operations, Stewart et al. (2004) and LeGare (2002) found the Force XXI Battle Command Brigade and Below (FBCB2) to be extremely useful for tracking the progress of friendly units through time and space. The FBCB2 can analyze march time based on route speed, which can be extremely helpful when the goal is to simultaneously arrive at an objective, for example.

In sum, there are a variety of tools to collect data during a terrain analysis. However, maps and images do not represent a substantial amount of information, and many of the lessons learned from current operations (e.g., Cohen et al., 2006; Bradshaw, 2006; Stewart et al., 2004) stress the importance of complementing analytical tools with other converging sources of information, such as actual human observation of the AO. These additional sources of information can help capture other elements of terrain analysis, including both the physical terrain and the human factors that affect time and space. By getting to know your AO, one can begin to fill in the gaps that remain after traditional terrain analysis.

Developing knowledge of the cultural terrain. In particular, one aspect of terrain that maps, overlays, and satellite imagery may not convey is what Kipp, Grau, Prinslow, and Smith (2006) and others have referred to as the cultural or "human terrain—the social, ethnographic, cultural, economic, and political elements of the people among whom a force is operating" (p. 9). According to Lt. Gen. David Petraeus, "We used to just focus on the military terrain, now we have to focus on the cultural terrain" (Barnes, 2006). In fact, Strader (2006) has gone so far as to label culture "the new key terrain." The focus on culture has emerged in the broadening of several traditional military terms, such as adding civilian considerations to the former METT-T (Mission, Enemy, Terrain, Troops, Time) aspects of a mission (now METT-TC), and broadening the end state within a commander's intent statement to address the population in addition to friendly forces, enemy forces, and terrain.

In addition, new non-doctrinal terms have emerged to focus specifically on cultural considerations, such as Areas, Structures, Capabilities, Organizations, People, Events; (ASCOPE), (O'Hara, 2007). When analyzing areas with ASCOPE, it is essential to consider space not just in terms of physical boundaries, but in terms of cultural boundaries as well, such as tribal boundaries, neighborhoods, and so on (O'Hara, 2007). Similarly, analyzing structures within ASCOPE can help a small unit leader understand not only how a structure compresses space physically (e.g., the physical structure of a mosque may affect line of sight), but culturally as well (e.g., a mosque is entirely off limits because of its significance to the population). All of these terms are tools to help leaders consider the motivations and culture of the "green layer" (Cohen et al., 2006). Critically, understanding the cultural terrain can help a leader make more sophisticated time and space estimates than when she/he analyzes only the physical terrain.

For example, one could make time and space estimates about how long it would take to get from point A to B by looking at a satellite image or map. One could estimate the distance, estimate how fast one would be traveling, and determine the total time of travel. However, such basic estimates do not account for any aspects of culture such as market hours or holidays that would clearly impact travel time just as much as the physical terrain. Understanding the human terrain can have additional impact on avoiding IEDs as well. For example, if people in a building are avoiding a certain area of the building, it's likely that the avoided area contains a booby trap (Phillips et al., 1998).

The cultural challenges presented within the COE have required the military to change the way it trains. Previously, combat training centers (CTCs) secured massive amounts of land to provide the physical terrain necessary to conduct heavy force operations in preparation for combat with the Soviet Union (Barnes, 2006). Now, CTCs are changing their approach to meet the demands of the COE. Most notably, CTCs are employing methods for updating their live field exercises to include the human terrain as well. For additional realism, Arabic-speaking actors dressed in authentic Arab clothing are brought in to play the roles of insurgents, civilians, and town leaders. As Soldiers interact with these role players, they are prompted to consider the message that their actions send to the population. For example, Barnes (2006) describes how Soldiers were asked to consider what message a raised gun conveys during a routine conversation, or how a neutral civilian might feel after being handcuffed in front of his wife.

These findings, taken together, indicate the challenges that face small unit leaders as they strive to develop and use visualization skills in the COE. The ability to take complex non-obvious factors into account has been shown to be a key aspect of battlefield visualization expertise. At the same time, the multidimensional nature of the COE makes it much more compressed and complex in time and space than previous battlefields. Furthermore, the human terrain can impact time and space visualization as much as the physical terrain. These factors interact to make battlefield visualization more important and more challenging than it has ever been.

Kilcullen (2006) and Lawrence (1917) suggest that knowing the minute details of the area of operations is essential to the ability of small unit leaders to function effectively. Leaders need extensive knowledge of the AO to be able to visualize *all* of the factors that may affect their ability to operate in time and space in their environment. How can leaders acquire the detailed knowledge of the AO that they will need to visualize their battlespace?

The next step of the research was to conduct a CTA with small unit leaders to identify the visualization tasks and skills that they perceive as critical and to understand how they acquire and use knowledge about their AO, including the physical and human terrain. We also wanted to gather specific details from military personnel about their experiences, their skills, their knowledge requirements, and their methods for acquiring knowledge in the COE. While the CTA was the primary purpose of the research effort, a secondary purpose was to develop prototype visualization training. The data collected during the CTA would drive the training content, as described later in this report.

Cognitive Task Analysis Data Collection

The research team tailored CTA data collection methods to identify the cognitive skills required to visualize time and space in the COE. Some of the primary elicitation techniques for CTA are: text analysis, interviews, observation, and situational exercises. Each technique has its own strengths and weaknesses. For example, text analyses are useful to establish a baseline of knowledge prior to using other methods or in situations where access to personnel is limited. Interviews provide first person accounts of the domain being analyzed, but individuals are often not able to recollect cognitive processes in great detail. Observation of personnel in action allows researchers to capture information that might not be reported during interviews. Finally, situational exercises allow researchers to systematically alter aspects of the work to collect empirical data regarding the impact of those aspects on performance.

Method

Scenario-based CTA: General approach

The research team selected a situational exercise approach using small group workshops for VISTA knowledge elicitation. Situational context was provided by descriptive scenario materials. The workshop approach allowed for more efficient data collection than would have been possible in one-on-one interviews.

In the scenario-based CTA workshops participants were presented with operationally relevant vignettes within a larger scenario context. During a group discussion, participants were asked to develop COAs in response to the challenges in the vignettes. As the participants presented their COAs, facilitators questioned them about the critical time and space factors they took into account, the cues they observed, and techniques they employed at different points within the scenario. Participants were asked to share personal experiences in which they had encountered similar time and space challenges, and to explain how they had handled such situations.

The research team chose scenario-based CTA because it is an effective approach to identifying training needs when the goal is to ultimately develop scenario-based training. Participant input in the workshop is constrained to actual scenarios that will drive training content in the developed training system. This happens in two ways. First, the scenarios that are presented in the CTA are the same scenarios that will be used in the training. Therefore, the information captured in the workshops will be directly relevant to the training scenarios. For example, during the CTA a subject matter expert (SME) might explain how to decide where to set up check points while en route to an objective to conduct a cordon and search. During training development, an exercise could be created in which training participants identify key factors to determine where to set up checkpoints. The feedback training participants receive during the training can be composed of the actual considerations described during the CTA, captured in video, text, or graphics. Second, the workshop setting provides an opportunity to capture on video personal experiences related to key time and space training objectives. These video testimonials become a key component of training content. They are one method by which experienced personnel can describe the techniques they employed in situations in which there was no clear right or wrong answer. Following the previous example, an expert could explain on camera about a time when it was challenging to have all units arrive at their checkpoints simultaneously. Not only is this type of material authentic and engaging, but it challenges the training participant to think beyond simple right/wrong considerations.

Four scenario-based CTA workshops were conducted using prepared scenario materials and CTA probes and questions.

Scenario materials

To prepare for a scenario-based CTA, scenarios were developed prior to the workshop. For VISTA, SMEs on the research team developed one overarching scenario, a “week in the life” of a company commander in AO Grant in Tikrit, Iraq (see Figure 2). This scenario contained

five associated vignettes representative of current operations that small unit leaders would encounter in the COE (see Figure 3 for a sample screenshot of the terrain from one vignette). These vignettes were based on lessons learned from the Center for Army Lessons Learned (CALL), and the Battle Command Training Program (BCTP) as well as on discussions with operational personnel with recent combat experience and current schoolhouse instructors at the COIN Academy in Kuwait. The five vignettes were:

1. Cordon and Search with company providing outer cordon.
2. Quick Reaction Force to secure downed aircraft site.
3. Raid on a Safe House.
4. React to Improvised Explosive Device (IED).
5. Establish Joint Traffic Control Points (TCP) with Iraqi Police (IP).

Information about the scenario and the five vignettes was developed in "slide" format and presented in both digital and handout form to workshop participants. These slides described the mission and the situation using both graphics and text (see examples in Figures 2 and 3). Information within the presentation provided participants with all the key information needed to develop a concept of operations: OPORD extracts, relevant intelligence, and imagery of the AO and objectives.

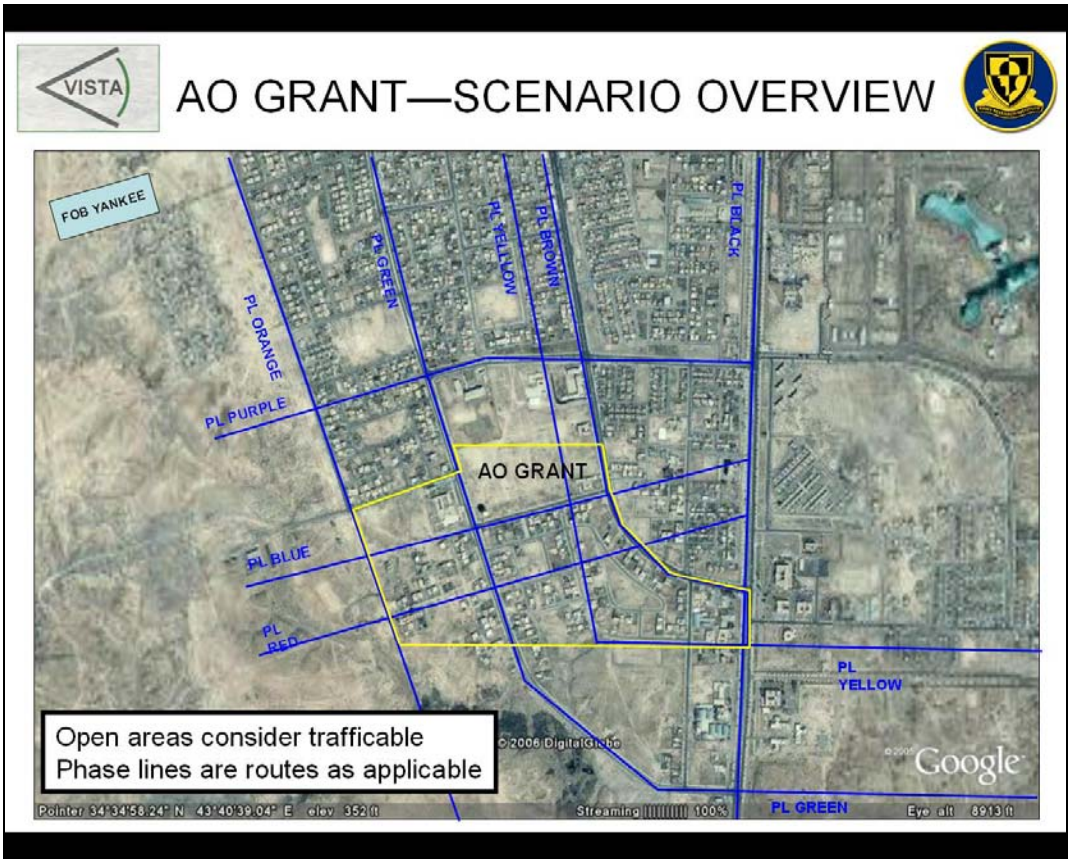

Figure 2. Example of scenario material: Fictional AO Grant and FOB Yankee in Tikrit, Iraq.

Figure 3. Screenshot from Cordon and Search vignette.

Probes/Questions

A list of questions was used as a guide during the Workshops, with additional questions asked of participants as appropriate. See Appendix B for a list of the questions used for the overall scenario and the specific questions used for the first vignette.

In the development of the questions/probes, researchers were careful to address major factors in time/space visualization within the COE identified in the previous literature. As noted earlier, Rosenberger (1996) identified critical questions a leader should ask to develop a visualization of the COE. Similar questions were developed for the CTA workshops that focused on space and time dynamics in the AO, as shown in the examples below for Vignette 2:

- Identify key terrain associated with establishment of Alamo per OCOKA (using map of AO).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?

        - Are there technologies that you don't have that would have been helpful to you?
        - What information does that help you obtain?
    - How do you know that you are successful in performing this task?
    - Is this different based on Phase I, II, or III?
        - If so, why?
        - What is different?
    - What is significant about the geography of Objective (OBJ) Texas?
- Determine best route (s), vehicle and foot from AA Haven to OBJ Texas (using satellite map).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
    - How do you operationalize best route?
    - What makes one route better than another? Why?

Workshops

The first workshop was planned as a pilot test of the scenario and associated vignettes and of the CTA questions. The goal was to obtain feedback from a few highly experienced personnel to ensure that the materials and the approach were perceived as relevant and were likely to elicit the type of information needed, and to make improvements before any subsequent workshops. Workshops 2-4 were then conducted using the revised materials.

Participants

The participants for Workshop 1 were two retired Colonels with over 20 years of military experience. For Workshops 2-4, participants were 48 company-level officers from Fort Hood, Fort Knox, and Fort Lewis. The participants were predominantly captains (37), but also included lieutenants (10) and one sergeant first class. The participants held a range of duty positions including company commander (4), troop commander (2), rear detachment commander (3), platoon leader (8), executive officer (5), S1 (3), S2 (1), S3/AS3 (6), S4 (3) and battle captain (2). The remaining participants included Captain Career Course students, a chaplain, and a budget officer. Thirty-six of these participants reported having been recently deployed to Iraq and/or Afghanistan. Subsequent discussions refer to the participants with deployment experience as "experts" and the participants with no deployment experience as "novices." Participants for Workshops 2-4 were made available through the Army's Umbrella Week program.

Recording Equipment

The CTA workshop sessions were recorded using either digital video camera and/or digital voice recorder to capture participants' responses for partial transcription, tabulation and analysis.

Procedure

The CTA Workshop 1. The goal of CTA Workshop 1 was to obtain feedback on the materials and processes planned for subsequent workshops. The CTA interviews were conducted over the telephone individually with two experienced participants.

Participants were informed of the purpose of this research. In addition, participants were informed of the pilot nature of this CTA and told that they would be asked to provide feedback regarding: (1) the operational relevance and "believability" of the scenario and associated vignettes, (2) the procedures associated with the conduct of the CTAs, (3) the value of specific probes used to elicit information regarding time and space considerations, and (4) specific time and space considerations they use when conducting the types of missions outlined within the vignettes.

Participants were then presented with the opening brief which explained the topic of visualization both according to Army doctrine and according to the demands of the present project. It was explained that visualization for the present project focused on understanding time and space considerations in a complex, multidimensional urban environment. Participants were then introduced to the overarching scenario of a "week in the life" of a company commander in AO Grant. Participants selected two vignettes to complete most closely related to their prior military experience. The vignettes included slides on the mission they were to plan for, the assets available, and different satellite images of the objective. Participants were then briefed on the two selected vignettes, one at a time.

Following the scenario and vignette briefs, participants were given 20 minutes to develop a concept of operations (CONOPS). After developing the CONOPS, they were asked to briefback their intended CONOPS to the research team. During the briefback, the research team questioned the participants with respect to time and space considerations following Rosenberger's (1996) guidelines, such as: why they chose certain routes, how they estimated the time required to move along the route, what information they were considering when making these estimates, and what cues along the route would allow them to know whether the mission was unfolding as planned. These steps were repeated for each vignette. At the end of the sessions, participants were asked to assess the operational relevance and "believability" of the scenario and vignettes. They were also asked to provide feedback regarding ways to improve the CTA procedures as well as specific feedback regarding the probes used.

Feedback from this session allowed the research team to refine the procedure. In general, the participants believed that the vignettes would be a valuable tool for eliciting knowledge from active duty operational personnel. However, they suggested that handouts be provided to the participants for their own reference. They also suggested that one participant in the group be designated to be the commander for a given vignette, and that the commander should lead a short planning session in which the team developed a concept of operations. Based on the results from CTA Workshop 1, the research team modified the procedures to include: (1) identifying and assigning a commander for each group, (2) providing handouts of the slide presentation for each participant, (3) allotting a 20 minute planning session to develop CONOPS, and (4) including an opportunity for participants to conduct a briefback to the research team.

The CTA Workshops 2-4. The research team conducted additional CTA workshops with a total of 48 participants at Fort Hood, Fort Knox, and Fort Lewis. The sessions occurred over two days at each location, and involved multiple sessions per day (morning and afternoon). Each session contained small groups (3-5 participants) and lasted approximately three hours. For approximately a third of the sessions, enough participants were present to warrant dividing the participants into two groups.

Each session began with introductions of the research team and their specific roles within the CTA (to describe the purpose of the research, to describe the scenario, and to facilitate and record the session, respectively). Participants were first presented with a consent form that explained the purpose of the research, assured them that their contributions would remain anonymous, and informed them that they might be videotaped during the course of the session. Participants then completed a background form which addressed their total years of experience, deployment experience in Operation Iraqi Freedom (OIF) and/or Operation Enduring Freedom (OEF), branch, and current and previous duty positions. Next, the research team provided an overview on the purpose of the research, the topic of commander's visualization in general, and how it was being focused on time and space dynamics for the current company and platoon research effort (see Figure 4).

Following the briefing regarding time and space visualization, participants were introduced to the AO Grant scenario. At this stage, each group was asked to select two vignettes that were most closely related to their relevant experience. The SMEs then selected a commander from among the participants based on rank, deployment experience, or experience relevant to a vignette. The SMEs then delivered a short briefing on the first of the two selected vignettes. Participants were given approximately 20 minutes to develop a concept of operations, using whiteboards or butcher paper as necessary (see Figure 5). During this time, the commander facilitated the discussion while the research team observed from the back of the room. Participants were encouraged to trace their plan on the whiteboard or butcher-block paper on which the map of AO Grant was projected. Participants were also encouraged to utilize different map views based on their specific needs.

Figure 4. A member of the research team delivering the introductory briefing.

Figure 5. Participants developing a concept of operations.

After development of the CONOPS, group leaders were asked to brief their plan to the research team. During the CONOPS briefing, researchers asked questions related to specific time and space factors considered during CONOPS development (example questions are available in Appendix B). For example, participants were asked to estimate how far AO Grant was from FOB Yankee, how long it would take to get there, and to identify specific trouble areas along the route using the satellite image. This process was repeated for subsequent vignettes. Following the last CONOPS briefing, participants were asked to talk about their personal experiences addressing the demands of visualizing time and space within the COE. Researchers watched for stories that were particularly compelling in terms of the time and space challenges they presented or stories that were particularly informative with regards to techniques for visualizing time and space and noted them for possible use in future training content. Some participants were asked to stay after the session to capture those stories on video for potential inclusion within the final training product. Participants were also asked to discuss the value of the vignettes as a basis for training and for their thoughts regarding the need for time and space visualization training and possible training methods. After the sessions, participants were thanked for their time, asked if they had any questions for the research team, and dismissed.

Analysis

The CTA sessions yielded a variety of data in the form of videos and audio recordings of the sessions and facilitator notes. The research team analyzed these data to produce tables that identified the time and space visualization skills needed within the context of the COE scenario and the vignettes, the specific knowledge required to effectively practice these skills, and promising techniques for acquiring that knowledge.

The organization of results was based, in large, on the methods used to analyze the CTA data. Phillips et al., (1998) organized their CTA results around task-focused and task-independent decision requirements. According to Phillips et al., task-focused decision requirements correspond to distinct stages of a task and task-independent requirements represent

judgment and assessment skills that should shape decision-making within each stage of the operation.

Initial CTA data were organized around the five vignettes and participants' COAs developed in response to each vignette. The data in this format represent task focused requirements. As a means to identify broader requirements that span across missions, the research team then combined the CTA data across vignettes and focused on the common elements of the COAs discussed during the CTA sessions. Though the vignettes differed significantly from one another, there were common elements throughout the COAs as described below.

- Pre-mission Preparation: Conducting Pre-Combat Checks (PCC) and Pre-Combat Inspections (PCI); rehearing missions with Iraqi units; using patrols as opportunities for mission rehearsal; talking to battle captains.
- Movement from the Forward Operating Base (FOB) to the Objective: Selecting ingress routes; determining the goal of the movement (speed vs. risk); determining order of movement; identifying paved roads; considering time of day.
- Mission Execution: Maintaining communication; creating proper spacing between units; identifying blocking points and check points; maintaining calm among local civilians.
- Movement from the Objective to the FOB: Identifying a safe egress route; determining an order of movement; remaining unpredictable by anticipating what route the enemy expects you to take.
- Post-mission Review and Analysis: Conducting after action reviews; creating storyboards; briefing incoming units.

Having organized the data according to the COA common elements described above, the research team next compared the reorganized data to our literature review findings. Rosenberger's (1996) critical time and space questions once again provided a useful framework, particularly for analyzing data regarding movement to and from the Objective (e.g., where will terrain restrict your movement?). Kilcullen's (2006) and Lawrence's (1917) articles also provided specific techniques for getting to know your AO and to helping others know your AO.

Organizing the CTA data as task-focused or task-independent has implications for transfer of training. Goldstein and Ford (2002) identify two major learning/training theories in relation to skill transfer to the work environment. The first theory, identical elements theory, is adopted from classical training and application environments and states that transfer will occur as long as there are the same elements in the training and applications environments. This appears to be consistent with Phillips et al., (1998) operational description of task-focused requirements. The second theory, principle theory, states that training should focus on the global principles necessary to learn a task so that the learner may apply them to a novel situation. This theory appears consistent with Phillips et al., (1998) definition of task-independent requirements. This will be critical during subsequent prototype training development. Through the identification of task-independent requirements, the eventual training product leverages "principle theory" to increasing transfer to the variety of missions and AOs which small unit

leaders operate within. In fact, finding commonalities across missions supports this notion of transfer.

After defining task-focused requirements and task-independent requirements for time and space visualization in the COE, it became clear that a level of detail was missing. Researchers went back to the data and identified the specific knowledge requirements that enable effective time and space visualization at both the task-focused and task-independent levels.

Results

The major results from analysis of the CTA data were: (1) insight into how the visualization skills and knowledge of experienced commanders and leaders differ from those of less experienced commanders and leaders; (2) confirmation that the task- independent visualization principles identified from the literature apply to leaders of small units in the COE; (3) identification of the task-specific time and space visualization skills required in the COE; (4) identification of the specific AO knowledge requirements that are needed to put those skills into practice; (5) identification of a core set of techniques that may be used to effectively gain, maintain, and share knowledge of the AO; and (6) confirmation of the need for visualization training in small units.

Differences in visualization for more-experienced and less-experienced commanders

During the CTA Workshops there were noticeable differences between the ways that experts (i.e., participants with deployment experience) and novices (i.e., participants with no deployment experience) approached the vignettes. For example, the seemingly simple task of estimating the time it takes to move from the FOB to specific control points can become complicated in an urban environment. While there were no right or wrong answers related to this question, experts routinely considered more factors (e.g., time of day, time of year, conditions of roads, proximity to markets and other businesses) than novices, who considered the more obvious factors (e.g., distance and speed of vehicles). This finding extends to distribution of resources (vehicle and personnel) and mission planning as well, where novices were unable to sort out relevant visualization resources from less relevant visualization resources. This confirms earlier findings (Serfaty et al., 1997) that a key component of expertise in visualizing the battlefield is the ability to perceive the complexity in a situation. Less experienced commanders fail to consider critical factors in their visualization. The CTA results suggest that including all of the relevant dimensions of the COE in visualization tasks is a key skill to be learned.

Task-independent time and space visualization principles

The CTA results confirmed expectations based on the literature. For the COE, effective performance requires an understanding of the interaction of time, space and human elements within that environment. Space and time are more compressed and more complex in the COE compared to prior battlefields, and the human element intensifies this compression and complexity. The research team developed four principles of visualization in the COE to capture these concepts:

- Time is compressed in the COE. Enemy attacks occur quickly and suddenly, using the element of surprise to force Army units into a reactive mode.
- Space is compressed in the COE. For example, dense congregations of buildings, narrow alleys, and road intersections tend to crowd friendly forces into targeted kill zones that have been previously identified by our enemies prior to engaging Army units.
- Human terrain further compresses time and space. For example, our enemies take advantage of civilians and traffic to conceal their locations during an attack and to avoid direct fire from Army forces. Human terrain is dynamic and changes much more quickly than the physical terrain. Indeed, human terrain may even have the impact of physical terrain if a crowd blocks a given route.
- Knowing your AO can help you exploit time and space. Expert leaders overcome these challenges through visualization skills that draw on specific knowledge about their AO. For example, they can anticipate how long it will take to get to key landmarks, plan their maneuvers based on known traffic patterns and routes, and know where they can quickly, on the fly, access additional information about their AO.

The fourth principle ("Know your AO") may seem obvious, but it is at the core of the CTA findings regarding visualization training needs. Less experienced leaders failed to consider all of the relevant aspects of the COE in visualizing the likely outcomes of their actions. Their fundamental handicaps in effective visualization were: (1) lack of knowledge about the aspects of the AO that should be included in the visualization (e.g., consider whether pedestrian crowds may slow travel progress on a planned route); (2) lack of detailed information about relevant aspects of the AO (e.g., there is a point on a planned route where markets that generate large crowds are usually held on Wednesday afternoons); and (3) lack of knowledge about techniques to acquire the information that is needed (e.g., how does one find out that markets are important and when they occur). These three aspects of "Know your AO" were identified as the major training needs for effective visualization. A major result of the CTA for training design and content development was the generation of a wealth of detail about these three aspects of effective visualization in each of the five vignettes.

Based on the CTA results the research team identified three task-independent stages of knowing your AO:

- Gaining knowledge of the AO.
- Maintaining knowledge of the AO.
- Sharing knowledge of the AO.

Soldiers can gain knowledge of their AO while in the Continental United States (CONUS) or upon first arriving to the AO. While deployed, Soldiers need to maintain and update their knowledge of the AO to adapt to changing circumstances. Prior to returning to CONUS, Soldiers need to share their knowledge of the AO with the incoming unit, who will be looking to gain knowledge of the AO. Building and refining knowledge of the AO, therefore, becomes a continual process.

Task-specific visualization skills

The CTA results yielded many examples of how the ability to visualize time and space using detailed and explicit knowledge of the AO can help small unit leaders to operate effectively. More specifically, knowing the AO allows the leader to:

- Plan efficient routes of movement.
- Visualize, dynamically, where members of the unit are in relation to specific landmarks within the AO.
- Visualize, dynamically, where members of the unit are in relation to others in order to coordinate movements.
- Recognize deviations from planned mission timing and spacing so that timing and spacing control procedures may be applied.
- Anticipate likely enemy troop movements.
- Anticipate communications obstacles in order to develop communications workaround plans.

Knowledge requirements for task-specific visualization

Detailed knowledge of the AO allows the small unit leader to exercise the visualization skills critical to effective operations. The CTA data yielded many examples of the specific knowledge of the AO that is critical for leaders. The list below describes the types of knowledge required followed by an example of the purpose of developing the knowledge. A complete mapping of knowledge requirements to task-specific visualization skills are given in Appendix C. These requirements are roughly organized by knowledge of the physical terrain and knowledge of the human terrain.

It is important to note that some of these knowledge requirements may have both a physical and human terrain component. Indeed, depending on the situation, a human terrain element may literally become a physical terrain element. For example, when enough civilians are present on a normally navigable route, the sheer volume of human traffic may become a physical barrier thus transforming human terrain into physical terrain.

Furthermore, although data collection was focused on small unit leaders, knowledge requirements may be relevant to small unit Soldiers more broadly. Small unit Soldiers are placed in situations in which they must lead, even if they are not official commanders or leaders. As such, these requirements are framed within the context of Soldier knowledge to recognize that any small unit Soldier may have to lead in response to emerging circumstances.

Knowledge requirements of the physical terrain. Knowledge requirements of the physical terrain can be gauged using both standard and emerging terrain analysis methods, such as OCOKA and ASCOPE (O'Hara, 2007). The following requirements provide the appropriate level of detail for small unit terrain analysis, including:

Road/Route Navigability: Examples: Understand trafficability issues related to movement within the AO such as the structure of roads (hardball vs. dirt), width of roads, navigability of

alley ways, navigability of open fields, and the presence of obstacles (i.e., low hanging wires, trash, etc.). Example use: plan the most efficient route.

Major Landmarks: Examples: Know locations of major landmarks within the AO (e.g., underpasses, bridges, tunnels, tactical control points, airstrips, major businesses/markets, homes of leaders). Example use: Soldiers can communicate their location quickly to other Soldiers within the AO.

Buildings/Structures: Examples: Know the building/structure specifics (e.g., number of floors, number of exits, access to rooftops, access to adjacent buildings, access to underground routes, building materials). Example use: Soldiers may better estimate the necessary space to cordon to contain threats.

IED Attacks: Examples: Know the specifics regarding IED attacks (e.g., locations/neighborhoods, frequencies, methods, ingress/egress routes). Example use: anticipate where insurgents may attack and what routes they may use to escape.

Vehicle Capabilities and Limitations: Examples: Know the capabilities and limitation of friendly vehicles (i.e., width, height, seating capacity, fuel economy, fuel capacity, noise, top speeds, armor). Example use: Soldiers can accurately calculate time to destinations, how long they may stay out on patrol, and safe operating distance.

Weapon System Capabilities and Limitations: Examples: Understand the capabilities and limitations of friendly weapons systems (lethal range). Example use: Soldiers can accurately estimate the safe space needed and establish effective fields of fire.

Enemy Weapons System Capabilities and Limitations: Examples: Understand the capabilities and limitations of enemy weapons systems (lethal range). Example use: Soldiers can accurately estimate the space needed to maneuver safely.

Enemy Ingres/Egress: Examples: Know the enemy's most common methods of ingress and egress (e.g., highways, alleys, buildings, underground, blending into crowds). Example use: Soldiers may better plan distribution of troops and patrols within the AO.

Communications Interference: Examples: Understand the impact of urban environments on communications equipment (e.g., tall buildings may interfere with ground-based radios). Example use: Develop an effective communications backup plan.

Time of Day: Examples: Understand how the time of day impacts navigability of routes (e.g., alleys and fields are often filled with trash at night, low hanging wires are less visible at night). Example use: Soldiers can estimate the time required to move between locations.

Knowledge requirements of the human terrain. Knowledge requirements of the human terrain can be gauged concurrently with standard terrain analysis to address "the social, ethnographic, cultural, economic, and political elements of the people among whom a force is

operating" (Kipp, Grau, Prinslow, & Smith, 2006). Knowledge requirements of the human terrain include:

Civilian Impressions: Examples: Understand civilian impressions of Soldiers in different neighborhoods. Example use: Soldiers can anticipate resistance by local adults and/or "crowding" by children looking for candy which can affect the ability to move in these areas.

Humanitarian Projects: Examples: Understand humanitarian projects in which the incoming/outgoing units have been involved (e.g., hospitals, schools, electric, water, fuel, and sewer). Example use: Soldiers can anticipate resistance from locals based on project status as well as anticipated vehicles and pedestrian traffic from these projects.

Enemy/Insurgent Impressions: Examples: Understand the enemy/insurgent impressions of Soldiers. Example use: Soldiers may anticipate the likelihood of enemy attack. For example, units that were perceived to be vigilant and aware (hard targets), were less likely to be attacked.

Unit Readiness Levels: Examples: Understand unit readiness levels of supporting and supported units (e.g., U.S., joint, and coalitions). Example use: Anticipate delays due to fatigue, insufficient training, etc.

Time of Day: Examples: Understand how the time of day affects human activities and the flow of human traffic. Example use: Notice if normal market traffic is missing.

Time of Year: Examples: Understand how the time of year impacts the flow of human traffic (e.g., in summer months, locals do their shopping and farming). Example use: Plan to avoid heavy traffic areas.

Table 1 provides a sample mapping of the relationships between task-specific visualization skills and specific knowledge requirements. A full mapping is available in Appendix C. It is important to note that these relationships were identified by the research team and were not confirmed with workshop participants. Future research should confirm these results.

Table 1

An Example of Knowledge Requirements and Objectives for Knowing Your AO

Tasks Requiring Visualization			
Knowledge Requirement	Planning Efficient Movement Routes	Anticipating Likely Enemy Movements	Recognizing Any Deviations from Plan
Buildings/Structures	x	x	x
IED Attacks	x		
Vehicle Capabilities and Limitations	x		x
Communications Interference	x		

Techniques for knowing your AO

Participants described a variety of techniques they employ in order to obtain the knowledge requirements for effective visualization of the COE, to include:

- Study mission packets at home station.
- Attend Intelligence and Situation Briefs with the outgoing, incoming, and sister units as possible.
- Maintain awareness and vigilance while on routine patrols (be the hard target).
- Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly versus unfriendly neighborhoods.
- Use easy to remember labels when naming major landmarks.
- When on routine patrols and missions, communicate your location to the rest of the unit to provide others with situation awareness.
- Utilize routine patrols to learn timing to move between checkpoints.
- Utilize routine patrols with Joint elements to practice communication and coordination plans.
- Utilize routine patrols to control friendly patterns of activity (e.g., to establish patrol patterns or to break/interrupt patrol patterns). Collect and review historical pattern analyses related to IED attacks.
- Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.).
- Document friendly tendencies/patterns when patrolling (e.g., time of day, number of vehicles, etc.). When estimating distances using maps and satellite images, estimate unknown large distances by first estimating smaller and known ones (e.g., use the known size of a city block to estimate distances between checkpoints).
- Plan extra planning time when working with newer or multinational units.

- Collect and review "black lists" of militants/insurgents in and around AO.
- Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (e.g., consider using airborne assets as a "communications tether").
- Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census.
- Receive and deliver Right Seat Rides.
- Tailor your visualization tools to the specific mission (visual perspective versus map perspective versus oblique perspective).
- Attend AARs.
- Create/utilize sand tables.
- Create storyboards.

While the direct linkages between knowledge requirements and the strategies that allow one to develop knowledge of the AO were not always rigorously specified in the CTAs, the research team developed a mapping of knowledge requirements to techniques for acquiring that knowledge. Table 2 provides an example, with the full mapping available in Appendix D. Based on participant accounts, the techniques can and should support the attainment of multiple knowledge requirements.

Table 2

An Example of Relations between Knowledge Requirements and Knowledge Acquisition Techniques

Knowledge Requirement	Techniques Used to Develop Knowledge
Buildings/Structures: Know the building/structure specifics (e.g., number of floors, number of exits, access to rooftops, access to adjacent buildings, access to underground routes, building materials) so that Soldiers may better estimate the necessary space to cordon to contain threats.	• Collect information through pictures (i.e., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Attend intelligence (INTEL)/situation briefs (SITBRIEFS) with the outgoing, incoming, and sister units as possible. • Attend AARs.
IED Attacks: Know the specifics regarding IED attacks (e.g., locations/neighborhoods, frequencies, methods, ingress/egress routes) in order to anticipate where insurgents may attack and what routes they may use to escape.	• Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Collect and review historical pattern analyses related to IED attacks
Vehicle Capabilities and Limitations: Understand the capabilities and limitation of friendly vehicles (e.g., width, height, seating capacity, fuel economy, fuel capacity, noise, top speeds, armor) so that Soldiers may accurately calculate time to destinations, how long they may stay out on patrol, and safe operating distance.	• Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Attend AARs. • Receive and deliver Right Seat Rides. • Utilize routine patrols to learn timing to move between checkpoints.

Knowledge acquisition techniques by stage

As described above, there are three stages of AO knowledge: getting to know your AO, maintaining that knowledge, and sharing that knowledge. Some techniques for knowledge acquisition apply to all three stages while others are specific to one stage.

First, one must gain knowledge of the AO. This can happen while still in CONUS and upon arriving in the AO. Attending briefs and AARs, sitting in on Right Seat Rides, and having informal conversations with the outgoing units are all techniques for gaining knowledge of the AO. Second, one must maintain knowledge of the AO while stationed there. Techniques for maintaining knowledge of the AO include engaging the population, creating a census of the local population, and taking pictures of key people and places. Lastly, one must share knowledge of the AO with incoming units. Those new units will be looking to gain knowledge of the AO, and the outgoing unit should aid in this process. The outgoing unit can conduct operations with the incoming unit, share storyboards from past missions, and give tours of the AO.

As noted, Table 3 identifies a small but multi-purpose set of selected techniques for gaining, maintaining, and sharing knowledge of the AO. These techniques evolve and the required knowledge accumulates over the course of exposure to the AO.

Table 3

Selected techniques for gaining, maintaining, and sharing knowledge of the AO

Techniques	Gain	Maintain	Share
Pictures/Images	Collect/review pictures/images of people, places, and things from outgoing units.	Take pictures of people and places during patrols and make a pictorial "census" of the AO.	Pass on pictures/ images of people, places, and things to incoming units.
Right Seat Rides (RSRs)	Participate in RSRs with outgoing units.	Participate/deliver RSR with other units.	Deliver RSRs to incoming units.
Engage the population	Ride along with outgoing units to see how they interact with civilians and leaders.	During routine patrols, get out of your vehicles and talk to civilians and leaders.	Take incoming units along on routine patrols to introduce them to civilians and leaders.

The need for visualization training

The CTA participants reported only a few examples of training directly focused on improving their visualization skills. One example was the "what-if" exercises that leaders initiate with subordinates during down-time. These casual thought exercises are employed to help Soldiers consider contingencies that could arise during an upcoming mission. Another example of low-tech visualization is a memory exercise in which one participant studies an assortment of objects. The objects are then covered, and one or more are removed. When the objects are uncovered, the participant must identify which objects have been removed. This

exercise is designed to develop the ability to discern when things are out of place. According to Soldiers, it is this very skill that can alert you to changes in your AO that could indicate danger (e.g., fresh dirt could indicate where an IED was placed).

Several participants cited their opportunities to participate in simulator-based exercises as an example of visualization training. They seemed to view simulation-based training as useful due to the high-fidelity nature of the context (e.g., recreating a city in Iraq), the agents (e.g., simulating enemy activity), and the equipment (e.g., using common weapons and communications systems). However, many participants stressed the cost and particularly the unavailability of simulation during deployment.

Overall, nearly all the participants underscored a serious need for additional training on visualizing their complex, unpredictable, and often intentionally disordered AO. During the workshops, as participants considered time and space factors for their COAs they stressed how the COE is often counterintuitive. Initially, their AOs were environments riddled with paradoxes that turned "upside-down" or reversed many of their familiar patterns and principles for visualizing operations. Over time, some of the more confident stated that they had learned to observe and absorb their AO until its unfamiliar and counterintuitive patterns gradually become more intuitive.

In addition, several participants remarked that the CTA's scenario-based exercises and group discussions felt like training and would be valuable for others to experience. In particular, the participants without deployment experience reported that the planning and discussion of time and space issues for the COA's provided valuable preparation for their own future deployments.

Discussion

The CTA sessions with military personnel confirmed and extended findings from the literature to include: (1) the key to effective time and space visualization is gaining, maintaining, and sharing knowledge of the AO; (2) knowledge of the AO supports needs that span a variety of missions (task-independent); (3) knowledge of the AO can be operationally defined as "specific" knowledge requirements (task-focused); and (4) these knowledge requirements can be met by learning and utilizing a core set of techniques. Results also confirmed the need for time and space visualization training (e.g., "I wish I had this type of training.").

The importance of getting to know your AO from the CTA results is a theme consistent with the review of the literature (Kilcullen, 2006; Lawernce, 1917). This includes understanding the physical terrain and its impact on time and space (Rosenberger, 1996), as well as the human terrain (Strader, 2006; Cohen et al., 2006). Kilcullen (2006) stressed the importance of knowing your AO at both a physical and cultural level (as does the present research effort), and suggested some of the same techniques for getting to know your AO that emerged during the CTAs:

> Study handover notes from predecessors; better still, get in touch with the unit in theater and pick their brains. In an ideal world, intelligence officers and area experts would brief you. This rarely happens: and even if it does, there is no substitute for personal mastery. Understand the broader "area of influence" - this can be a wide area, particularly when

> insurgents draw on "global" grievances. Share out aspects of the operational area among platoon leaders and non-commissioned officers; have each individual develop a personal specialization and brief the others. Neglect this knowledge, and it will kill you (pp. 103).

The current results extend these findings in key ways. First, this research decomposed knowing your AO into three stages: gaining knowledge, maintaining knowledge, and sharing knowledge with others. The fluidity of knowledge suggested by these stages is consistent with Leedom's et al., (2007) findings on building, synchronizing, assessing and exploiting commander's visualization at the battalion level.

In addition, this research initiated a template for mapping knowledge and skill elements to associated techniques and stages of knowing your AO. While the mapping in the current research effort is notional, future research should validate the relationships between these critical elements of visualization. In addition to extending the body of visualization research, a formal mapping between elements would provide a validated framework upon which to develop training.

Training Development

The primary objective of the current effort was to identify and analyze the skills required to visualize time and space in the COE. The secondary objective was to develop a limited training program consisting of prototype training materials to help leaders learn these skills. Based on the CTA results, the research team developed initial training materials to introduce training participants to the principles of visualization, the stages of knowing your AO, and the techniques for gaining, maintaining, and sharing knowledge of the AO within realistic vignettes. The training is described here and in detail in the accompanying Research Note (Sidman & Garrity, 2007).

Training strategy

The goal was to develop training that would provide the opportunity for small unit commanders and leaders to practice time and space visualization techniques across the stages of knowing your AO within realistic vignettes. Our training objectives in each module, therefore, were to apply techniques for gaining, maintaining, and sharing knowledge of the AO in a variety of missions common to small unit leaders in the COE.

For example, the training objectives in Module 2: Cordon and Search were to utilize information from the outgoing units (gain), acquire information from the population and arrange the virtual sand table (maintain), and to develop a concept of operations and a storyboard to share with incoming units (share) (see Figure 6).

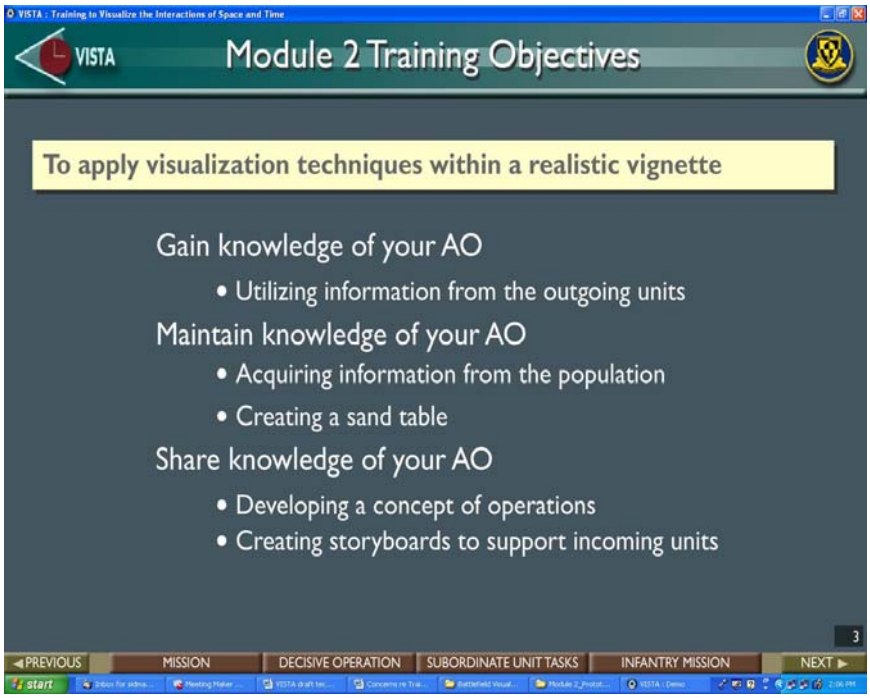

Figure 6. Module 2 Training Objectives.

In Module 5: React to IED, the training objectives were to use routine patrols as opportunities for mission rehearsal (gain), create a concept of operations and arrange a virtual sand table (maintain), and update the interactive map with information about a recent incident (share) (see Figure 7).

In developing the VISTA prototype training to meet the above training objectives, we relied on three central instructional methods that have been shown to maximize the effectiveness of the resulting system: deliberate practice, multimedia presentation, and scenario-based context. Together, these strategies should act to enhance the depth of understanding and the likelihood of retention (e.g., Ericcson, Krampe, & Tesch-Romer, 1993; Ericcson & Lehman, 1996; Lussier, Shadrick, & Prevou, 2003; Mayer, 1997).

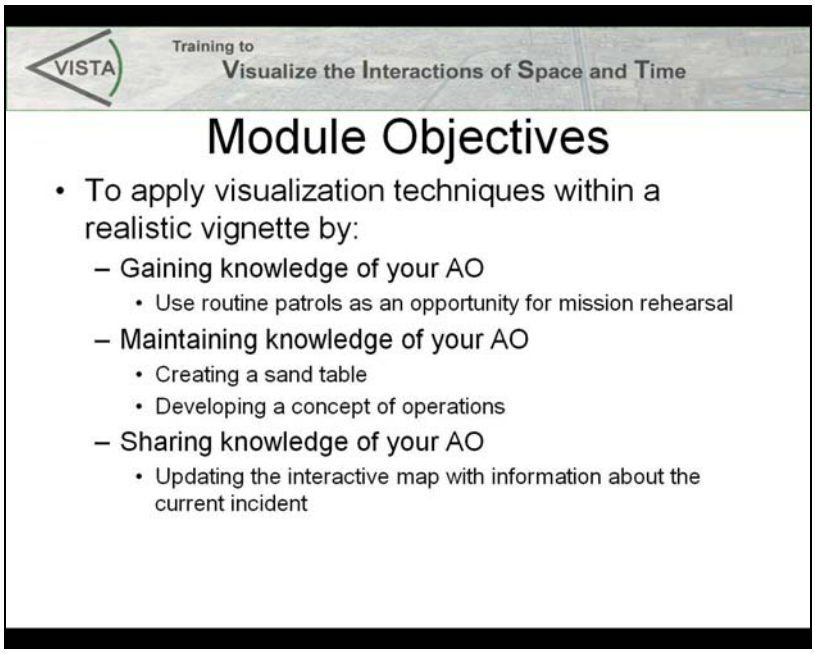

Figure 7. Module 5 Training Objectives.

Deliberate practice

Certain training approaches are substantially more efficient than others in developing expertise. A substantial body of research suggests that the acquisition of expertise is directly related to the amount of deliberate practice (Ericcson et al., 1993; Ericcson & Lehman, 1996). Historically, the deliberate practice method has been used to train physical skills such as the martial arts and cardio-pulmonary resuscitation (CPR). Recently, however, the technique has been used for training cognitive and decision-making skills as well (Lussier, Shadrick, & Prevou, 2003).

The principles of deliberate practice include several key elements. First, one must identify the elements of expert form. The learner must perform the task while consciously attending to these elements. In addition, a coach should be provided who notes discrepancies from expert form and provides remedial feedback. Lastly, the training must provide multiple opportunities for practice over time (Ericcson, et al., 1993; Ericcson & Lehman, 1996).

Deliberate practice differs from other training approaches in several key ways (Lussier et al., 2003). First, deliberate practice involves a high degree of repetition to develop expert habits that are near automatic in their application. Second, deliberate practice involves focused feedback to help learners better target their areas of weakness, thereby conserving limited training resources. Third, deliberate practice provides the learner with immediate feedback so that areas of weakness can be targeted early. Finally, deliberate practice typically involves active coaching with a high instructor-to-student ratio (Lussier et al., 2003). Alternatively, an instructorless training system that leverages effective feedback mechanisms may provide the same active coaching effect as a high instructor-to-student ratio. The end result could be a highly efficient technique for accelerating the development of skilled performance.

Multimedia training

The VISTA training approach rests on extensive research that has been carried out by cognitive and educational psychologists to understand the memory processes involved in learning from multimedia presentations. In the present context, for instance, multimedia materials might consist of multi-format (words, pictures, movies, diagrams) and multi-modal (visual, auditory) information sources. The challenge is the creation of multimedia materials that not only convey the necessary information, but that do so in a cognitively appropriate manner.

For instance, an extensive literature emphasizes the importance of presenting information in a way that considers memory structure. For VISTA training, the key finding of this research is that while you may overload memory by presenting too much material in a single format, people can generally process multiple formats simultaneously, thereby increasing the amount of information that can be processed in a given time period (Baddeley, 1992; Brunyé, Taylor & Rapp, 2003, 2004a; Logie, Zucco, & Baddeley, 1990; Mayer & Anderson, 1991; Robbins, Anderson, Barker, & Bradley, 1996).

Moreover, multimedia presentations support the active formation of connections between presented images, videos and diagrams, and simultaneously presented text and/or narration, increasing the chances of retention. Hence, while repetition of information in a single format may be useful under certain circumstances, the research literature clearly indicates that multi-format redundancy introduces a beneficial learning effect, far outweighing any learning advantages seen following single-format repetition (Brunyé, Taylor, & Rapp, 2004c).

The benefits of such multi-format (multimedia) presentations is seen when learners passively retrieve information as well as actively apply the learned materials to novel circumstances (Brunyé, Taylor & Rapp, 2004b; Mayer, 1997). Complementing these memory benefits, multimedia presentations also ensure accommodation of learning style differences by providing alternative and preferred information sources (Mayer, 1993). Based on these findings, therefore, a key design strategy for VISTA training was the use of multimodal and multi-format information sources to facilitate learning and remembering.

Scenario-based training

The VISTA training should provide deep and contextually rich knowledge. The active engagement of learners in working with and forming connections between materials is an important aspect of facilitating learning and comprehension, as indicated by a large body of literature (e.g., Mayer, 1997; Soraci, Carlin, Chechile, Franks, Wills, & Watanabe, 1999; Slamecka & Graf, 1978; Wittrock, 1989). The VISTA training relied on small unit scenarios/stories within the COE, collected during the CTA Workshops, as well as facts drawn from multiple sources. In VISTA, scenarios were developed with SME input to ensure operational relevance. Likewise, the training materials leveraged videos of interviews and operational conditions to provide context and grounding in operations. Indeed, in general there is evidence that the development of transferable skills from learning environments to other environments is enhanced by grounding instruction in a range of rich contexts (Brown, Collins & Duguid, 1989; Lintern, 1989; Liu, Williams, & Pedersen, 2002; Singley & Anderson, 1989). As

a result, in developing the VISTA training we based our instructional materials on scenario-based approaches to ground the knowledge in context.

Content development

A significant advantage of conducting a scenario-based CTA for VISTA is that the time and space considerations supplied by active duty personnel in response to the vignettes during the CTA workshop could be transferred directly to training exercises based on the same vignettes. To guide the implementation of the CTA content within the training system, the research team relied heavily on a matrix of knowledge acquisition techniques by stages of knowing your AO (see Table 2 in the above Results section).

Exercises based upon the instructional methods described above were the vehicle for presenting key time and space visualization techniques to training participants. This happens in several ways, as described here and in the accompanying Research Note (Sidman & Garrity, 2007). For example, CTA participants described key questions to ask an outgoing unit before conducting a cordon and search, such as "Which neighborhoods are supportive of our efforts?" Based on that feedback, a thought exercise was created in which training participants would have to gain knowledge of the AO by considering what questions to ask an outgoing unit during informal conversations. One of the considerations within the training is, "Which neighborhoods are supportive of our efforts?" as shown in Figure 8.

Another way of including CTA results in training is through video clips of CTA participants. In addition to being an engaging method for presenting content, these videos provide authenticity and credibility to the training content. Through these video clips, an experienced leader might describe strategies employed in actual engagements (e.g., a cordon and search) and the consequences of those decisions. Or the expert might have a particularly effective way of communicating a key concept. In one CTA session, for example, an expert described how to create a storyboard of a recently completed mission. This explanation was captured on video and included in the training content.

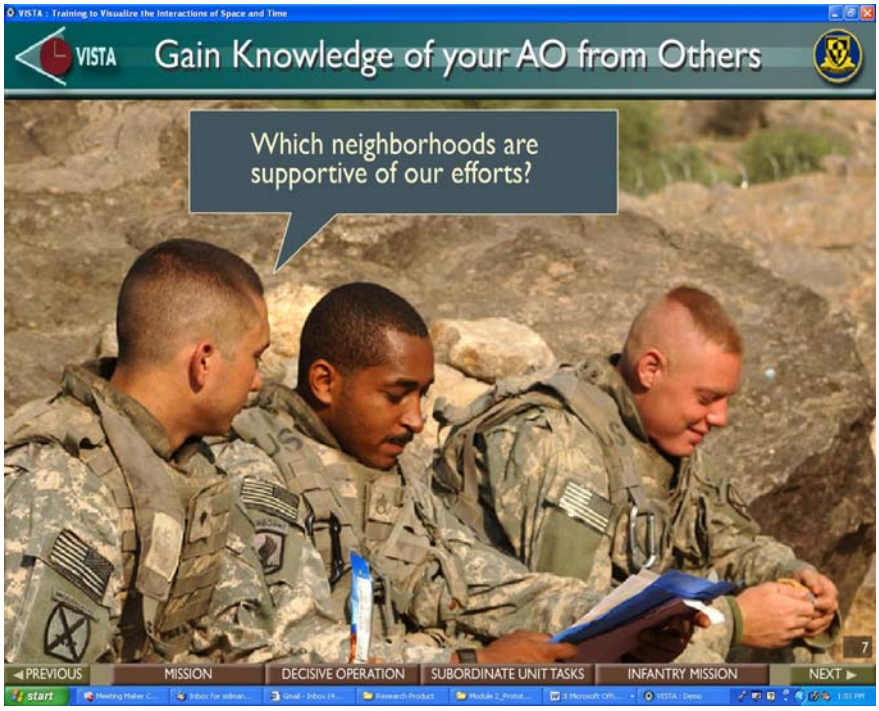

Figure 8. Consideration identified by an expert leader during the CTA is included as feedback in a training exercise.

Implementation of VISTA training prototype

In order to demonstrate and receive feedback on VISTA training concepts, the research team created storyboard prototypes for five training modules. Storyboards provided static versions of the training modules (see Figure 9). The storyboards included the following:

- Training objectives.
- Graphical user interface concepts.
- Performance feedback mechanisms.
- Scenario structures, events, and tasks.
- Training intervention concepts.
- Description of a participant's training experience.

We created five module storyboards as the basis for the prototype VISTA training (see Appendix B for sample storyboard screenshots). The five modules were:

- Module 1: Introduction.
- Module 2: Cordon and Search.
- Module 3: Deploy a QRF.
- Module 4: Raid on a Safe House.
- Module 5: React to IED.

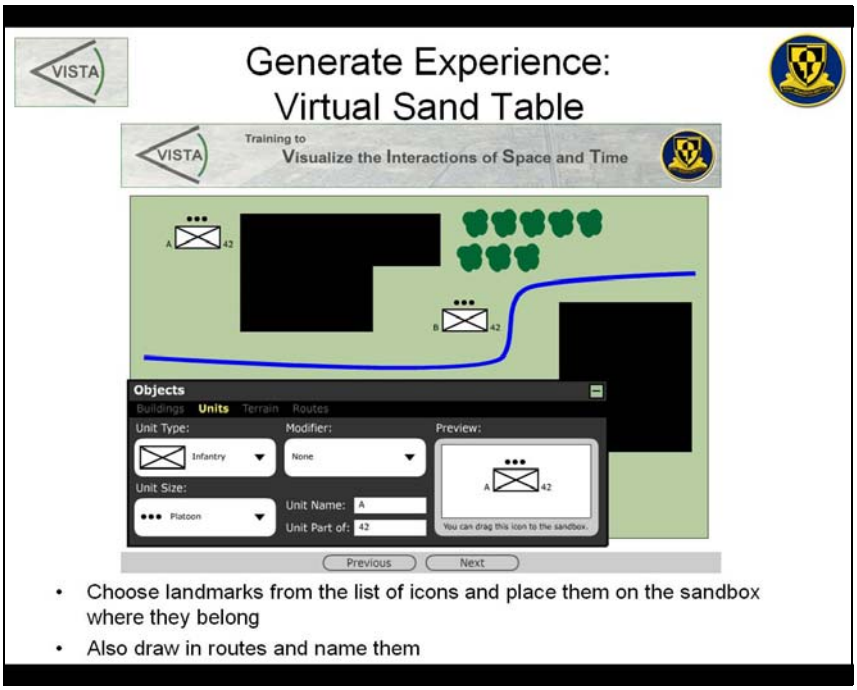

Figure 9. A screenshot from a storyboard explaining the sand table exercise.

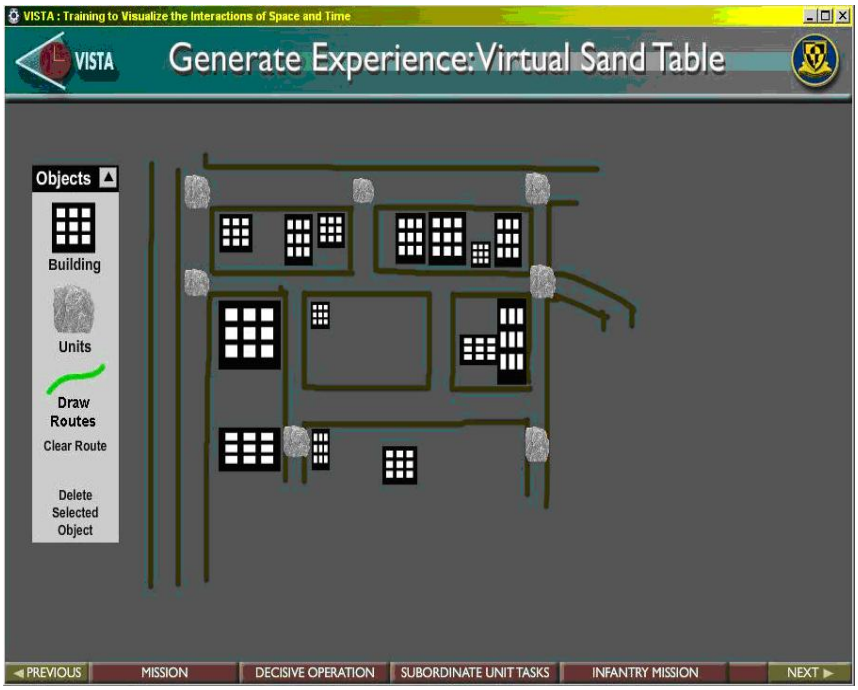

Figure 10. The sand table exercise implemented in Adobe Flash®.

The research team developed storyboard versions of each vignette from the CTA except for the "Establish Joint TCP with IP" vignette. The CTA participants explained that they no longer conduct TCP missions in this manner, so this module was eliminated.

In addition to the storyboards, the team implemented the prototype "Cordon and Search" module in an interactive platform. The platform selected was Adobe Flash because of its enhanced interactive capabilities, invulnerability to link breakdowns, and ability to run on any computer without requiring any downloads or installations. Figure 10 shows the implemented version of the sand table exercise shown in the storyboard of Figure 11. The five training modules are described in considerably more detail in the accompanying Research Note (Sidman & Garrity, 2007).

Training Feedback and Assessment

The research team conducted a limited evaluation of the prototype VISTA training. The purpose of the evaluation was to receive feedback on the storyboard of Module 1: Introduction and feedback on the implemented prototype, Module 2: Cordon and Search. In particular, the evaluation addressed:

- Clarity of content: Relevance to operational personnel including correct terminology and symbology; clear objectives; logical sequences of events.
- Usability: Self-explanatory navigation, simple operability, useful features.
- Transition opportunities: Potentially interested schoolhouses or units.

Method

Participants

Five retired colonels from MPRI participated in the evaluation of the prototype training modules. Each participant had over 15 years of military experience in the Operations, Infantry, and/or Armor branches of the U.S. Army. In addition, three instructors from the COIN Academy in Kuwait reviewed the training materials independently of the more formal training evaluation. Unfortunately, development delays and resources available did not permit extension of the evaluation to members of the target audience small unit commanders and leaders. Revised versions of these training modules will be evaluated by small unit commanders and leaders in future research efforts.

Procedure

Because participants were not co-located, the training evaluation was conducted via teleconference. Three two-hour teleconference sessions were conducted with the retired Colonels. There were two participants in each of the two sessions on the first day, and one participant in the session on the second day.

Each session began with brief introductions of the VISTA team and the participants followed by an overview on the purpose and progress of the VISTA project to date, providing the context for the training evaluation.

The military SMEs then led the evaluation participants through an introductory briefing. The purpose of the briefing was to familiarize participants with the CTA methodology and

results in order to provide the context for training development. The briefing was based on the presentation that was used during the CTA sessions conducted earlier. A military SME first presented the topic of visualization by doctrine and for the purposes of the project, then presented the AO Grant scenario, and then the five supporting vignettes. A representative of the research team then presented a high-level summary of the CTA findings. The representative described the importance of knowing your AO in making more accurate time and space estimates, and described some strategies in which one can gain, maintain, and share knowledge of the AO.

The participant(s) then reviewed the storyboard of Module 1: Introduction. The module presented many of the ideas from the introductory briefing, such as defining visualization in doctrinal and non-doctrinal terms. The representative described the functionalities that would be incorporated in a fully implemented version of the module. Participants asked questions and offered comments throughout the presentation.

The participant(s) then reviewed the prototype Module 2: Cordon and Search. A member of the research team demonstrated the various functionalities of the module to ensure that the participants understood its intended use. As with Module 1, participants asked questions and offered comments throughout the presentation.

Lastly, participants were emailed a one-page survey to document reactions to the training. The survey included the following questions: "Three things that I wouldn't change about the VISTA training are," "Three things I would change about the VISTA training are," and "What schoolhouses do you think would be interested in the VISTA training?" They returned the survey within one week of the training evaluation. The COIN Academy instructors also completed and returned similar surveys.

Results

Overall, participants reported that the VISTA training included many innovative ideas and would be useful in a variety of schoolhouses. Responses to each question are provided below.

Three things I wouldn't change about VISTA: With respect to the prototype module content, participants found a variety of the features of the training to be effective. In particular, the videos from CTAs were described as a strength of the training, as was the capability to link to key documents such as field manuals. However, participants were most impressed with the interactive map and the virtual sand table. These features were considered the most innovative approaches to visualization training within the prototype module. Detailed descriptions of these features can be found in the accompanying Research Note (Sidman & Garrity, 2007).

Three things I would change about VISTA: While the training received a favorable review, the majority of comments were suggestions for improvement. A repeated concern expressed by the SMEs was a lack of training feedback and assessment. As one participant noted, "Task 3.d.1 indicates the requirement to compare the students' performance to 'peers and

experts.' In my opinion something is missing. I am left hanging. Yes there are the video clips from the so called experts but what is the method to compare?"

Indeed, the comparisons between training participant and expert opinions can be made more explicit in future versions of VISTA. However, the videos do have value nonetheless as they capture opinions from active duty personnel with experience visualizing time and space in the COE.

Participants also identified ways in which some of the key features of the prototype module could be improved. For example, the interactive map currently provides a satellite image of the AO with a menu of overlays that display attack history, ethnic distribution, and phase lines. The interactive map would benefit from having pop-up descriptions of the recent incidents. When placing the cursor over the incident icon, a pop-up would provide information about the "who, what, where, when, and why" of the incident. The map would also benefit from having a zoom capability that would allow participants to view not only the satellite view of the AO, but the street level view as well.

The sand table currently provides a drawing area upon which the training participant can place objects (buildings, units, and routes) by selecting them from a menu and dragging them to the proper location. The sand table would benefit from having a way to include common military symbology to identify units. The key to labeling units, however, would be to provide ready-made labels in order to minimize the physical effort involved in preparing the objects to place in the sand table and to maximize the cognitive effort in arranging the objects on the sand table. The sand table would also benefit from a wider variety of objects such as vehicles, trees, and rivers. Furthermore, even though the intent of the sand table was to provide a low-fidelity rehearsal capability, participants believed that higher-fidelity images should be used as objects. For example, the Building object could be an image of a traditional Iraqi house instead of an abstract square building.

The sand table could be modified to provide more structured sandbox exercises with explicit time and space feedback. For example, the sand table exercises might require participants to actually make time and space estimates (e.g., what routes would they take to get from the FOB to the AO and how long would it take). Then the feedback could provide both "novice" examples of poor performance and "expert" examples of good performance for the same task required by the exercise. This feedback could both visually illustrate (on the sand table) and textually reinforce the teaching points regarding poor and good performance.

In addition, some SMEs cautioned against a technology-based approach to training. Soldiers often do not have access to computers to run the VISTA training. According to one SME, "In our real world environment over here this tool could help the company commander and his platoon leaders, but they might not have the computer support out in some of the remote bases to fully utilize the tool (i.e. laptops)." Therefore, VISTA as a CD-based training tool may be most applicable during pre- and post-deployment training. Printouts of the training materials may better suit the needs of deployed Soldiers. For example, the illustrative storyboards could be printed and provided to trainers as a guide for developing similar time and space training vignettes for their AO.

What schoolhouses do you think would be interested in the VISTA training: Participants believed this training could be useful at a variety of schoolhouses including:

- Armor/Infantry Basic and Advanced Officer and Non-Commissioned Officer (NCO) Courses.
- Combat Arms Schools.
- Combat Service Support (CSS) School.
- Engineer School.
- Military Police (MP) School.

Summary

The feedback from the limited training evaluation was encouraging. Participants endorsed the approach to the VISTA training and suggested a variety of schoolhouses that would be interested in the training product. In addition, they were particularly pleased with the operational relevance of the vignettes. Furthermore, they found the innovative visualization features such as the interactive map and the sand table to have tremendous training potential, and suggested specific recommendations for improvement. Future work should be focused on implementing the suggested changes as the product is refined.

Summary of VISTA Research

The multidimensional nature of the COE compresses and complicates the dynamics of space and time in a way that challenges small unit leaders as they visualize the COE. The enemy appears suddenly and leverages his knowledge of the terrain to restrict friendly responses. Aspects of the COE that were not present in previous engagements, such as areas and structures of cultural significance as well as civilians themselves, become a key element of the terrain. This complexity of the COE can make even basic time and space estimates (e.g., how long will it take to travel from one location to another) challenging.

A scenario-based cognitive task analysis was conducted with active duty small unit leaders to identify the key cognitive skills required for visualizing time and space in the COE. Participants were presented with vignettes representative of common small unit missions (e.g., Cordon and Search, React to IED), and generated COAs in response to the vignettes. The research team asked questions to assess how participants visualized time and space as they generated their COAs.

Four principles of time and space visualization at the small unit level in the COE emerged from the results. The first principle, "Time is compressed in the COE," reflects the fact that enemy attacks occur quickly and suddenly, using the element of surprise to force units into a reactive mode. The second principle, "Space is compressed in the COE," emphasizes the dense congregations of buildings, narrow alleys, and road intersections that tend to crowd friendly forces into targeted kill zones that have been previously identified by our enemies prior to engagement. The third principle, "Human terrain further compresses time and space," stresses that the civilian population complicates and generally reduces your response options by, for example, allowing enemies to conceal their locations and avoid direct fire. The fourth and final

principle, “Knowing your AO can help you exploit time and space,” reflects how leaders can control and leverage the AO’s time and space patterns so they can anticipate how long it takes to get to key landmarks, plan their maneuvers based on known traffic and routes, notice and act on irregularities, and know where they can quickly access additional information about their AO.

Small unit personnel get to know their AO over three stages: gaining knowledge, maintaining knowledge, and sharing knowledge. The specific knowledge needed and the techniques for acquiring that knowledge vary for these stages. Specific techniques for gaining knowledge of the AO include attending briefs and AARs, sitting in on Right Seat Rides, and having informal conversations with outgoing units. Specific techniques for maintaining knowledge of the AO include engaging the population, using routine patrols as opportunities for mission rehearsals, and taking pictures of key people and places. Finally, specific techniques for sharing knowledge of the AO with incoming units include conducting operations with the incoming unit, sharing storyboards from past missions, and giving tours of the AO.

Small unit personnel require training on visualizing time and space in the COE. The CTA results provide a solid foundation for future training development. Based on the CTA results, prototype visualization training was developed in five modules that addressed techniques for acquiring, maintaining and sharing knowledge of the AO for four vignettes within an overall scenario. The scenario-based training materials were grounded in principles for the effective use of multi-media delivery and the need for deliberate practice.

The current research contributes to identifying and understanding the skills required for visualizing time and space in the COE and the training requirements for these skills. Future training development efforts will benefit from the CTA findings particularly the identification of AO knowledge requirements and an extensive set of techniques for gaining, maintaining and sharing that knowledge. Training development efforts will benefit from the feedback obtained during evaluation of the prototype training modules. Notably, approaches to training and shaping visualization skills should include complementary low-technology (not computer-based) training formats for the austere environments often occupied by deployed personnel. Above all the findings model a training approach with feedback in the form of expert visualizations and considerations for mastering time and space challenges in the COE.

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Appendix A

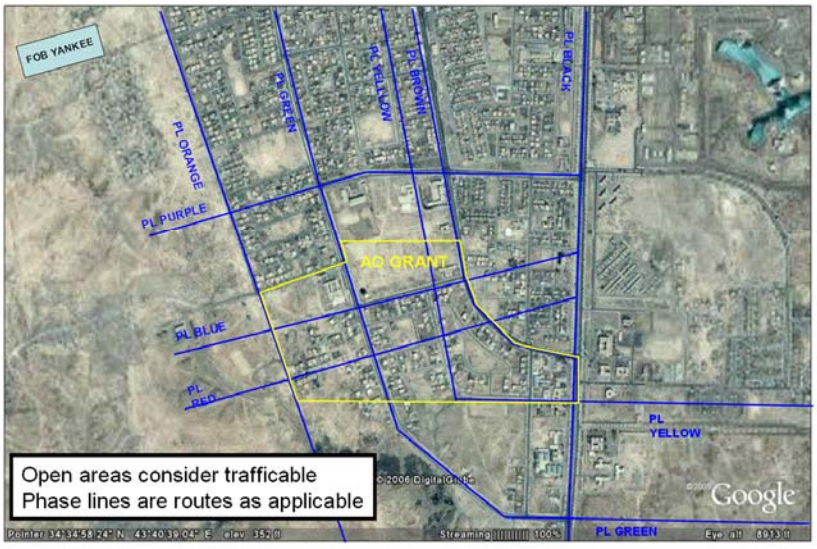
Sample Slides Used for CTA and Training

VISTA Scenario Unit Mission

OPORD Extract

- **Mission:** From FOB YANKEE, C/1-114 IN (LT), 36BCT (TF CROCKETT), 21 ID (L) conducts stability and support operations in AO GRANT IOT maintain a secure and stable environment to support new IRAQI government establishment of a viable, functioning IRAQI state.

AO GRANT—SCENARIO OVERVIEW



VIGNETTE 1

Cordon & Search OPORD EXTRACT

(U) Tasks to Subordinate Units:

- **(U)1-114 IN (LT) (-), 36BCT (TF Crockett), 21 ID (L) (MAIN EFFORT)**
  - **(U) C/1-114 IN-Establish outer cordon ALAMO and road blocks surrounding OBJ TEXAS NLT190100ZAPR06**
  - **(U) A(-)/1-114 INF - Establish inner cordon TRAVIS NLT190110ZAPR06**
  - **(U) B/1-114-Conduct cordon and search of residence of Dr. Maghib Al-Haqqadi in TIKRIT 190115ZAPR06 IOT confirm/deny the presence of IED supply and production facilities in the area and capture and detain suspect members of Jaysh Muhammad (JM) Cell**

Cordon & Search

VIGNETTE 2

Employ QRF

C/1-114 Infantry (LT):

- Mission: Provide one rifle squad Air QRF and two squad Ground QRF. Each QRF will have a Combat Lifesaver.
- Air QRF
  - Positioned at FOB YANKEE Helipad
  - Be prepared to deploy within AO GRANT or elsewhere within BCT AOI within 10 minutes of initial alert
- Ground QRF
  - Positioned at FOB YANKEE
  - Be prepared to deploy within AO GRANT or elsewhere within BCT AOI within 15 minutes of initial alert

Employ QRF

VISTA VIGNETTE 3

Raid on Insurgent Safe House with IED /VBIED Assembly Site—FRAGO Extract

- 1 (U) C/1-114 IN (L) conducts raid of residence of former Iraqi Army LTC, Al Amarah, in AO GRANT at 220100(L)APR06 to detain suspect members (3-4) of Al Faruq BDE (AFB)
- 2 (U) C/1-114 receive THT, 1/125MP(-), 4 personnel (2 female) and interpreter
- 3 (U) OH-58 will provide overwatch of raid site
- 4 (U) C/1-114 will link up with IP patrol NET220030(L)APR06 at FOB Gate

Raid on Safe House

VISTA VIGNETTE 4

React to IED/VBIED Within Company Patrol Area

- 1 (U) C/1-114 IN LT conducts two vehicular and two foot patrols in sectors GRANT-ALPHA and GRANT-BRAVO
- 2 (U) C/1-114 receive 2 each THT and 2 interpreters for link-up at FOB YANKEE Gate
- 4 (U) C/1-114 will link up with two IP patrols NET240800(L)APR06 at CP 7
- 5 (U) Vehicular patrols will include one each IP vehicle. Foot patrols will be accompanied by one IP representative

React to IED/VBIED

VISTA VIGNETTE 5

Establish AO Grant Joint TCPs With IP

- 1 (U) C(-)/1-114 IN LT establishes joint Traffic Control Points (TCP) with Iraqi Police on selected primary routes entering and intersecting AO Grant
- 2 (U) C(-)/1-114 receive THT, 1/125MP(-), 4 personnel (2 female) and 4 interpreters
- 3 (U) OH-58 will provide overwatch of AO Grant
- 4 (U) C(-)/1-114 will link up w/ IP patrol NET261000(L)APR06 at FOB Gate
- 5 (U) TCPs will be manned for no longer than 30 minutes.
- 6 (U) TCP 1-4 will be established NLT261100(L)APR06, followed by establishment of TCPS 5-8.
- 7 (U) C(-)/1-114 will consolidate at CP8 IOT to return to FOB YANKEE NLT261300(L)APR06

Establish Joint TCPs With IP

Appendix B

Sample CTA Questions

General Operational Experience Questions

- At what point in the planning process do you generally form your vision of how the operation will unfold?
- What are the components of battlefield visualization? (weather, *terrain, time*, enemy) METT-TC, OCOKA
    - How do these combine with each other?
    - How do combinations of these provide information that one alone does not?
- Do you generally have too much or too little information?
    - How do you determine what is relevant?
    - Was there information that you needed to have that you could not obtain?
    - Retrospectively, what should you have sought that you did not?
- What types of systems and products are available to assist you?
    - Which are most helpful to you?
    - Which are least helpful to you?
    - Which component of visualization (e.g., weather, terrain, time, enemy) do they address?

Training Questions

- What type of training have you received in battlefield visualization?
- Have you ever received training in battlefield visualization?
    - Where was the training conducted? Unit or Schoolhouse?
    - What type of visualization training did you have?
        - FTX?
        - CPX?
        - Simulator?
        - Computer-based?
        - NTC/CMTC/JRTC?
- Did you feel that the training you received was effective or ineffective? Why?
- Have you ever used battlefield visualization training in combat or field training exercise?
- What type of training would you have liked to receive?
- What do you think battlefield visualization training should consist of?
    - Specifically, what content areas? What instructional techniques?

Actual Event/Effective Performance

- Please describe an example of when you or someone you know effectively visualized the battlefield. (NOTE: Repeat question to collect information about multiple examples.)
    - Please tell us a little about the background.
    - Who were the key players?
    - What did each of them do?

- Why was this example particularly effective?
- What were the primary skills involved?
- What was the primary "lesson learned" from this event?
- If you had to do it over again, what would you have done differently?

Actual Event/Ineffective Performance

- Please describe an example of a time when it was challenging to develop a visualization of the battlefield. (NOTE: Repeat question to collect information about multiple examples.)
  - Please tell us a little about the background.
  - Who were the key players?
  - What did each of them do?
  - Why was this example particularly ineffective?
  - What were the consequences?
  - What was the primary "lesson learned" from this event?
  - If you had to do it over again, what would you have done differently?

Vignette 1 (Setting Outer Cordon) Questions

- Organize C Company for combat—platoon tasks in accordance with (IAW) METT-TC (interviewees present their concept of operations using stickys and a blown-up map of the AO).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
        - What questions are you asking yourself to ensure that you are where you need to be?
    - Where did your intuition fail?
        - Can you attribute it to a reason?
- Identify key terrain associated with establishment of Alamo IAW OCOKA (using map of AO).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
        - Are there technologies that you don't have that would have been helpful to you?
        - What information does that help you obtain?
    - How do you know that you are successful in performing this task?
    - Is this different based on Phase I, II, or III?
        - If so, why?
        - What is different?
    - What is significant about the geography of objective (OBJ) Texas?
- Determine sequence of movement out of assembly area (AA) Haven (as demonstrated on blown-up map using stickys).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
- Determine "best" route (s), vehicle and foot from AA Haven to OBJ Texas (using satellite map).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?

        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
    - How do you operationalize "best" route?
        - What makes one route better than another? Why?
- Determine placement of platoons/materiel resources to accomplish mission (Troops to Task Considerations) (interviewees present their concept of operations using stickys and a blown-up map of the AO).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
    - What technologies do you use in order to exchange information?
        - What information do you pull?
        - What information do you push?
    - How do you know that you are successful in performing this task?
    - How does time impact the placement of platoons/material resources to accomplish the mission?
- Determine time of movement from FOB to AA Haven and AA Haven to OBJ Texas IAW fragmentary order (FRAGO) guidance/restrictions (Space and Time) (using all maps).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
- Determine time from arrival at OBJ Texas to establishment of outer cordon Alamo (using maps and stickys).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
- Determine time required to establish road blocks preventing high speed escape from OBJ Texas (using maps and stickys).
    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?
- Determine location of Company CP (using all maps).

    - Given this task, what do you need to know or be able to do to perform this at a high level?
    - Who do you exchange information with?
        - What information do you pull?
        - What information do you push?
    - What technologies do you use in order to exchange information?
    - How do you know that you are successful in performing this task?

Visualization Questions

- Are phase transitions triggered by time or by cues?
    - What cues do you look for to indicate that you are transitioning between phases?
    - What cues do you look for to indicate that other units are in a particular phase, or are transitioning between phases?
- Where is visualization most important? Planning, execution, or assessment?
    - How do visualization demands change based on planning, execution, and assessment?
- How do you know the status of other units' mission progress?
    - How do you know when things are going well?
    - How do you know when things are not going well?
- In your opinion, what experiences would help you to develop the knowledge and skills needed to effectively visualize the battlespace?
- How do you deal with the perishable nature of information?
    - How do you determine if information you receive is still relevant?

Appendix C

Knowledge Requirements and Skills Matrix

	Plan efficient routes of movement	Visualize, dynamically, where members of the unit in relation to others	Visualize, dynamically, where members of the unit in relation to major landmarks	Recognize deviations from planned mission timing and spacing	Anticipate likely enemy troop movements	Anticipate communications obstacles
Road/Route Navigability	x			x	x	
Major Landmarks			x	x		
Buildings/Structures	x	x		x		
IED Attacks	x					
Vehicle Capabilities and Limitations	x			x		
Weapon System Capabilities and Limitations	x			x		
Enemy Weapon System Capabilities and Limitations					x	
Enemy Ingress/Egress					x	

Communications Interference	x					x
Civilian Impressions	x				x	
Humanitarian Projects	x				x	
Enemy/Insurgent Impressions	x				x	
Unit Readiness Levels	x	x		x		
Time of Day	x				x	x
Time of Year	x				x	x

Appendix D

Relationships between Knowledge Requirements and Knowledge Acquisition Techniques

Knowledge Requirement	Techniques Used to Develop Knowledge
Road/Route Navigability: Examples: Understand trafficability issues related to movement within the AO such as the structure of roads (hardball vs. dirt), width of roads, navigability of alley ways (presence of low hanging wires and trash piles), navigability of open fields, and the presence of obstacles (e.g., low hanging wires, trash, etc.). Example use: plan the most efficient route.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Collect and review "black lists" of militants/insurgents in and around AO. • Utilize routine patrols to control friendly patterns of activity (e.g., to establish patrol patterns or to break/interrupt patrol patterns). • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create/utilize sand tables.
Major Landmarks: Examples: Know locations of major landmarks within the AO (e.g., underpasses, bridges, tunnels, tactical control points, airstrips, major businesses/markets, homes of leaders). Example use: Soldiers can communicate their location quickly to other Soldiers within the AO.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Use easy to remember labels when naming major landmarks. • When on routine patrols and missions, communicate your location to the rest of the unit to provide others with situation awareness. • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create/utilize sand tables. • Create storyboards.

Buildings/Structures: Examples: Know the building/structure specifics (e.g., number of floors, number of exits, access to rooftops, access to adjacent buildings, access to underground routes, building materials). Example use: Soldiers may better estimate the necessary space to cordon to contain threats.	• Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Attending INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Attending AARs.
IED Attacks: Examples: Know the specifics regarding IED attacks (e.g., locations/neighborhoods, frequencies, methods, ingress/egress routes). Example use: anticipate where insurgents may attack and what routes they may use to escape.	• Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Studying mission packets at home station. • Attending INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Collecting and review historical pattern analyses related to IED attacks
Vehicle Capabilities and Limitations**:** Understand the capabilities and limitations of friendly vehicles (e.g., width, height, seating capacity, fuel economy, fuel capacity, noise, top speeds, armor) so that Soldiers may accurately calculate time to destinations, how long they may stay out on patrol, and safe operating distance.	• Attending INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Attending AARs. • Participate and deliver Right Seat Rides. • Utilize routine patrols to learn timing to move between checkpoints.
Weapons Systems Capabilities and Limitations: Examples: Understand the capabilities and limitations of friendly weapons systems (lethal range). Examples use: Soldiers may accurately estimate the safe space needed and establish effective fields of fire.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Participate and deliver Right Seat Rides. • Tailor your visualization tools to specific mission High Mobility Multipurpose Wheeled Vehicle (HUMVEE) Views v/s Predator Views v/s Oblique Views). • Attend AARs.
Enemy Weapons System Capabilities and Limitations: Examples: Understand the capabilities and limitations of enemy weapons systems (lethal range). Example use: Soldiers can accurately estimate the space needed to maneuver safely.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Collect and review “black lists” of militants/insurgents in and around AO. • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times,

	market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create storyboards.
Enemy Ingress/Egress: Examples: Know enemy most common methods of ingress and egress (e.g., highways, alleys, buildings, underground, blending into crowds). Example use: Soldiers may better plan distribution of troops and patrols within the AO.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Collect and review historical pattern analyses related to IED attacks. • Collect and review "black lists" of militants/insurgents in and around AO. • Collect information through pictures (i.e., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Attend AARs.
Communications Interference: Examples: Understand the impact of urban environments on communications equipment (e.g., tall buildings may interfere with ground-based radios). Example use: develop an effective communications backup plan.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • When on routine patrols and missions, communicate your location to the rest of the unit to provide others with situation awareness. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (i.e., consider using airborne assets as a "communications tether"). • Participate and deliver Right Seat Rides. • Attend AARs.
Time of Day: Examples: Understand how the time of day impacts navigability of routes (e.g., alleys and fields are often filled with trash at night, low hanging wires are less visible at night).	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • When on routine patrols and missions, communicate your location

	to the rest of the unit to provide others with situation awareness. • Collect and review historical pattern analyses related to IED attacks. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Document friendly tendencies/patterns when patrolling (e.g., time of day, number of vehicles, etc.). • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs.
Civilian Impressions: Examples: Understand civilian impressions of Soldiers in different neighborhoods. Example use: Soldiers can anticipate resistance by local adults and/or "crowding" by children looking for candy which can affect the ability to move in these areas.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Collect and review "black lists" of militants/insurgents in and around AO. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (e.g., consider using airborne assets as a "communications tether"). • Utilize routine patrols to control friendly patterns of activity (e.g., to establish patrol patterns or to break/interrupt patrol patterns). • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Attend AARs. • Create/utilize sand tables. • Create storyboards.

Humanitarian Projects: Examples: Understand humanitarian projects in which the incoming/outgoing units have been involved (e.g., hospitals, schools, electric, water, fuel, and sewer). Example use: Soldiers can anticipate resistance from locals based on project status as well as anticipated vehicles and pedestrian traffic from these projects.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Participate and deliver Right Seat Rides.
Enemy/Insurgent Impressions: Examples: Understand the enemy/insurgent impressions of Soldiers. Example use: Soldiers may anticipate the likelihood of enemy attack. For example, units that were perceived to be vigilant and aware (hard targets), were less likely to be attacked.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • Collect and review historical pattern analyses related to IED attacks. • Collect and review "black lists" of militants/insurgents in and around AO. • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create/utilize sand tables. • Create storyboards.
Unit Readiness Levels: Examples: Understand unit readiness levels of supporting and supported units (e.g., U.S., joint, and coalitions). Example use: anticipate delays due to fatigue, insufficient training, etc.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Plan extra planning time when working with newer or multinational units. • Utilize routine patrols to learn timing to move between checkpoints. • Collect and review "black lists" of militants/insurgents in and around AO. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (e.g., consider using airborne assets as a "communications tether"). • Participate and deliver Right Seat Rides.

	• Attend AARs. • Create/utilize sand tables. • Create storyboards.
Time of Day: Examples: Understand how the time of day affects human activities and the flow of human traffic. Example use: Notice if normal market traffic is missing.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods. • When on routine patrols and missions, communicate your location to the rest of the unit to provide others with situation awareness. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (e.g., consider using airborne assets as a "communications tether"). • Utilize routine patrols to control friendly patterns of activity (e.g., to establish patrol patterns or to break/interrupt patrol patterns). • Document friendly tendencies/patterns when patrolling (e.g., time of day, number of vehicles, etc). • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create/utilize sand tables. • Create storyboards.
Time of Year: Examples: Understand how the time of year impacts the flow of human traffic (e.g., in summer months, locals do their shopping and farming). Example use: plan to avoid heavy traffic areas.	• Study mission packets at home station. • Attend INTEL/SITBRIEFS with the outgoing, incoming, and sister units as possible. • Maintain awareness and vigilance while on routine patrols (be the hard target). • Engage the population regularly to collect information related to insurgent leadership, business hours of markets and mosques, and perceptions of incoming and outgoing units and insurgents, and friendly verses unfriendly neighborhoods.

	• When on routine patrols and missions, communicate your location to the rest of the unit to provide others with situation awareness. • Utilize routine patrols with Joint elements to practice communication and coordination plans. • Develop communications workaround plans when in urban environments where tall buildings may interfere with ground-based radio communications (e.g., consider using airborne assets as a "communications tether"). • Utilize routine patrols to control friendly patterns of activity (e.g., to establish patrol patterns or to break/interrupt patrol patterns). • Document friendly tendencies/patterns when patrolling (e.g., time of day, number of vehicles, etc.). • Utilize routine patrols to monitor civilian and insurgent patterns of behavior (e.g., meeting places, trash pick-up locations and times, market hours, locations where children play, etc.). • Collect information through pictures (e.g., people, housing, gates, markets, mosques, recreation fields, IEDs) to create a census. • Participate and deliver Right Seat Rides. • Attend AARs. • Create/utilize sand tables. • Create storyboards.